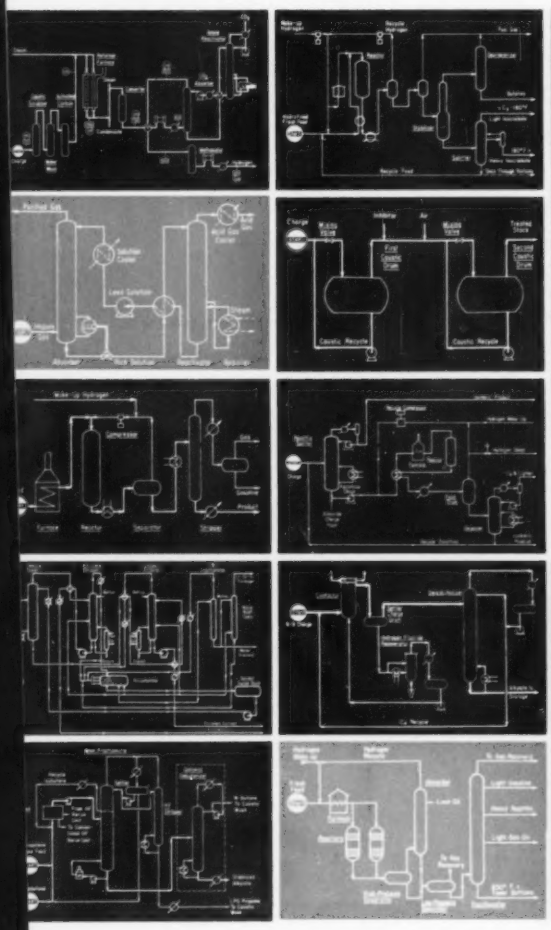
Petroleum
REFINER
SEPTEMBER 1960
FOR THE HYDROCARBON PROCESSING INDUSTRY

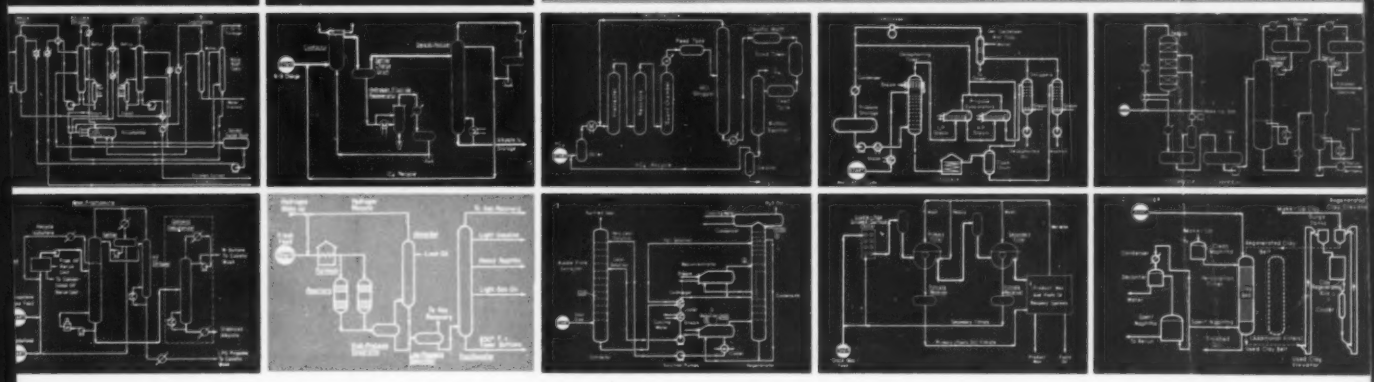


1960 REFINING PROCESS HANDBOOK

P. 175

★ 88 process descriptions showing flow diagrams

★ Quick Look at 9 process groups with comparisons



Check List for Better Cost Estimates 285
Trouble Shooting Electrical Problems 287
How to Select Foundation Size Easily 290
Getting Better Decisions from Groups 323

POSITIVE CONTROL OF *MATERIALS IN MOTION* BIF METERS FEEDERS CONTROLS

ON STREAM!

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reliable multicomponent blenders
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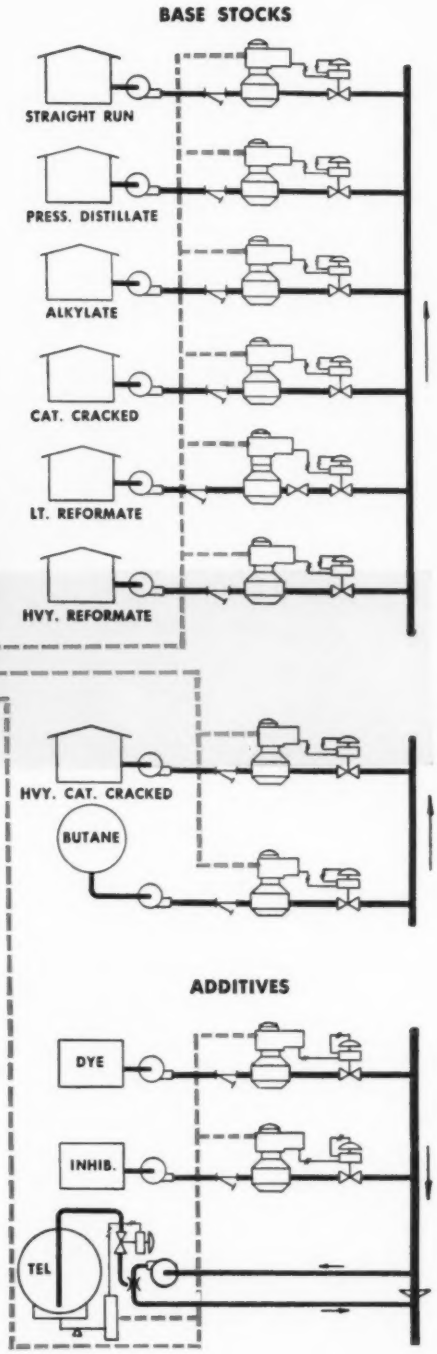

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Volume 39, No. 9 September 1960

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Petroleum Refiner
FOR THE HYDROCARBON PROCESSING INDUSTRY
A Gulf Publishing Company Publication

A Quick Look at This Issue

These handy digests permit checking the articles you want to read first. ☑

PROCESS HANDBOOK

☐ **1960 Edition . . .** Once again, you have an authoritative compilation of the most important refining processes in use today. You'll want to keep this handbook on your reference shelf because it's a complete and up-to-date picture of refining technology. Each process is described with application, charge, products, operating conditions, yields, economics, and commercial installations. If you want more detailed information, you can use the literature references also included. All of the important processes are here. Start your tour through modern petroleum refining on Page 175.

☐ **Check List for Better Estimates . . .** Use this valuable check list when transmitting data to estimating. To learn how the list's use can result in better estimates, turn to Page 285.

☐ **Trouble Shooting Electrical Distribution Problems . . .** From lightning troubles to underground terminators, Mobil's Beaumont refinery has had its share. Did you ever have termites eat their way up a 35-foot creosoted pole, out the arm, then chew off the insulator pins? Mobil did! You'll want to learn how they solved this and other problems. For one of the most interesting stories on electrical trouble shooting you have ever read, turn to Page 287.

☐ **Foundation Sizing Simplified . . .** Tables can be used to select foundations as easily as pump capacity tables are used to select that equipment. Typical cases of foundation loading are shown, with the tables developed for easy selection of foundation size. To see how to use these and make others for your needs, turn to Page 290.

Please Turn Page ➔

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A Quick Look at This Issue . . .

☐ **Applied Hydrocarbon Thermodynamics . . .** Part 21. Nomographs and Convergence Pressure Correlations of Vapor-Liquid K values . . . for the most convenient forms of K correlations take a look at this part of Professor Edmister's series. He also brings you up to date on other important correlations which have been made. See **Page 293.**

☐ **White Collar Unionization—Challenge to Management . . .** Management should take the time to consider the five main reasons why white collar workers join unions, and sometimes even seek out union organizers. There's a reasonable solution to each of these problems, too, as you will see from reading this article starting on **Page 305.**

☐ **How to Get Better Decisions from Groups . . .** Applied Group Dynamics: Part 5 . . . You'll be able to raise the quality of decisions from your group or committee after reading this article. It discusses the thought processes involved in reaching a group decision, plus power relationships usually found between the organization's members. You'll want to clip this part of a highly interesting series and review it before going to your next meeting. Turn now to **Page 323.**

When changing your address . . .

Subscribers should notify us promptly of any change in address.

Six weeks notice is required if you want to be sure of getting all copies of PETROLEUM REFINER without a skip.

Remember—Copies we mail to your old address will not be delivered by the Post Office unless you pay them extra postage.

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Petroleum Refiner

Box 2608, Houston 1, Texas

Next Month: How to Blend for Volatility

HAVE YOU been selling fuel volatility short? When you get down to it, volatility is just as important as anti-knock quality for making auto engines run powerfully and efficiently. That's why we've scheduled a 32-page special report on volatility for our October issue.

This report is complete and well illustrated with graphs and charts like the one below which shows that each engine problem due to volatility can be related to portions of the fuel's boiling range.

This special report will include sections on:

- Hot Weather Problems
- Cold Weather Problems
- Non-Seasonal Problems
- Goals for Volatility Blending
- How to Predict Gasoline Blends

Watch for Volatility in October.

ENGINE PROBLEM	FRONT END (10 — 30% Point)	MID RANGE (50 — 70% Point)	BACK END (90% Point)
COLD STARTING			
EVAPORATION LOSS			
VAPOR LOCK			
HOT STARTING			
HOT IDLE			
CARBURETOR ICING			
WARM-UP			
ACCELERATION			
BTU CONTENT			
OIL DILUTION			
CLEANLINESS			

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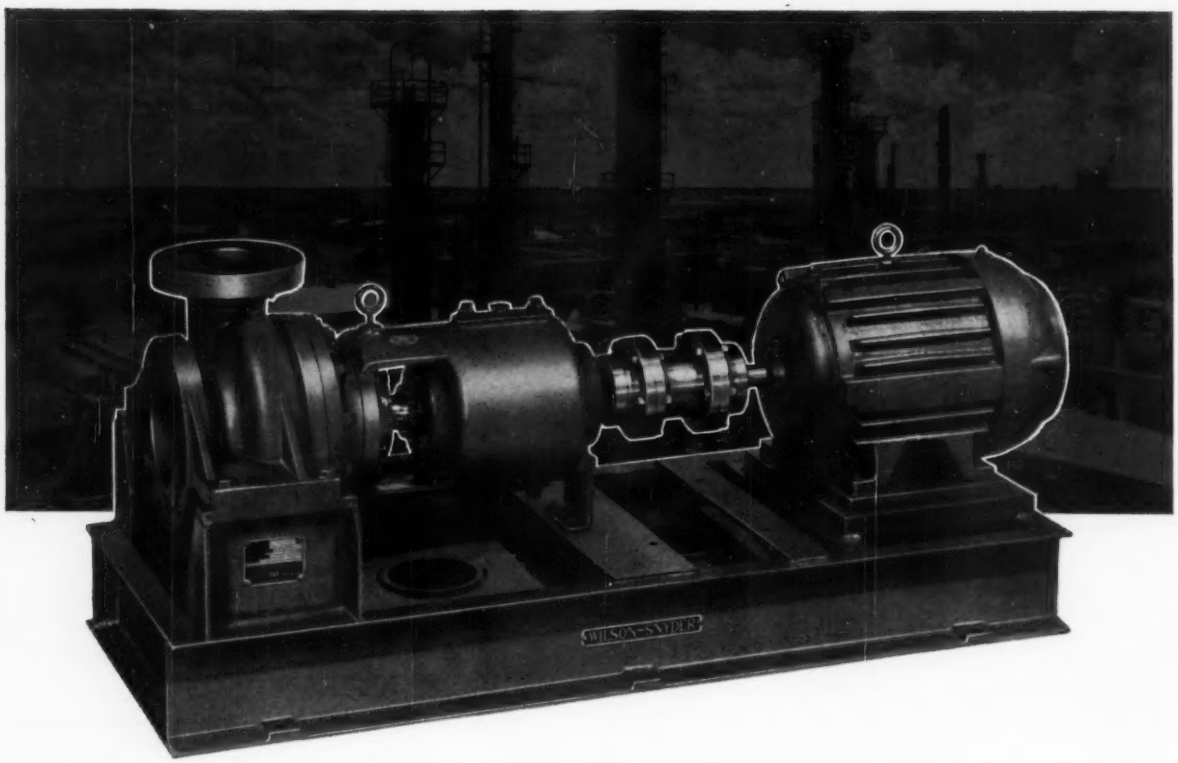

Wilson-Snyder announces a new line of heavy-duty Centrifugal Process Pumps—Type ESN

for maximum efficiency, dependability and economy

This all-new Wilson-Snyder Type ESN pump meets all and exceeds many of the requirements of A.P.I. Specifications and incorporates the following outstanding features:

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- Superior shaft design, with double row radial and double row angular contact type thrust bearings.
- Impeller designed for lowest possible NPSH without sacrifice of efficiency.
- Large effective cooling passages integral with stuffing box and bearing housing are designed for temperature applications up to 900 degrees F.

High-strength shaft design combined with double volute case design reduces shaft deflection to absolute minimum and allows widest possible range of operation. The double row ball radial and thrust bearings have been selected to assure long-life performance and lowest maintenance cost. Ring-oiled bearing lubrication with a large built-in oil reservoir provides positive and ample lubrication to all bearings. Stuffing boxes are designed for maximum packing standardization and all standard makes of mechanical seals can be applied interchangeably.

ESN pumps are available in a complete range of sizes, both single and 2-stage—end suction standard, top suction optional, on all single-stage pumps. Only five bearing bracket assemblies cover the complete line for horsepower applications up to 350. ESN pumps can be furnished in a wide range of metallurgy, including alloys suitable for highly corrosive and abrasive liquids.

Wilson-Snyder sales engineers

. . . at Chicago, Illinois . . . Dallas, Texas . . . Houston, Texas . . . Los Angeles, California . . . New York, N. Y. . . . Tulsa, Oklahoma . . . Pittsburgh, Pa . . . can furnish you with complete information on this new line . . . or call your nearest "Oilwell" representative.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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Simplest Solution

ARE YOU HIGH MAN on the totem pole insofar as the routing list of company magazine subscriptions are concerned? If not, then you will be lucky if you *ever* receive this, the biennial Process Handbook. Because of its reference value, it will be in high demand and someone whose name precedes yours may find a convenient cubby hole and there the issue may come to rest. It has been known to happen. Simplest solution: Let the other fellows do battle each month over the circulating copy. As for yourself, remain aloof from the fray by arranging for a personal copy of PR to be sent to your home. If your order comes pronto and you so request, we will start your subscription with the September issue *so long as the supply lasts.* If you can find a PR issue with a postcard inserted opposite the Table of Contents page, that would be the handiest way to do it.

"Easily the Best"

One of our editorial men, out on a trip recently, included this memo in his report: "Mr. X of the ABC Company, Tulsa, said they recently had a trainee from the United Kingdom touring their gasoline plants to get acquainted with gas processing in the United States. After this man spent several days with him, Mr. — told him if he wanted to keep up with the technology, he should subscribe to PETROLEUM REFINER. "PR" is easily the best magazine in the gas processing field," he declared.

This bit of testimony is recorded in hopes that it will help you or that gas processing friend of yours reach a hastier verdict that the thing to do is to fill out and mail the same postcard facing the Table of Contents page of this issue.

Oldsters Needed

Now and then a reader appeals for help in filling out a PRETROLEUM REFINER volume or file. Or maybe he just wants a back issue in order to clip certain articles for reference. Such requests are always gratifying because they are solid evidence of readership values. If the back issue is available, then everyone's happy. If "no soap," the editors' feelings are mixed, of course—glad to know the demand exists, sorry the back issue isn't on hand. Recently M. Head of Caltex Services Ltd. (Caltex House, Knightsbridge Green, London S. W.1) asked for PR issues dated January and February, 1956 and January, May, and June, 1957. The order was filled after a fashion, but it occurred to us that if any PR subscriber in the United Kingdom has such copies, he might care to communicate with Mr. Head. It's possible that a real need might be met, a real service rendered.

Charles H. Lane of Houston, a Gulf Publishing Co. director since 1918, died August 13. Present when PETROLEUM REFINER was born in 1922, he had been a friend and counselor of us all since that early day. Even though something of a link with the past, his thinking was always as up-to-date as petrochemical's newest process. That he will be missed goes without saying. He was a real standby.

UNRETOUCHED ACTION PHOTOS PROVE SUPERIOR PERFORMANCE OF BUELL CYCLONES

an ordinary cyclone

THE BUELL CYCLONE
with Shave-Off

These are photographs of as true a test as can be made under laboratory conditions. Notice the difference in the dust patterns! In the Buell Cyclone, on the left, the dust at the top makes less than one revolution before it is trapped by the Shave-Off. It's then channeled down to the lower portion of the Cyclone, well below the clean gas outlet.

Why is the Buell Shave-Off so effective? Primarily because it harnesses the double-eddy current to convey the dust "fines" downward quickly, thereby promoting greatly increased efficiencies. In the ordinary cyclone, as shown on the right, these "fines" concentrate and recirculate at the top, causing erosion of the cyclone. To be collected, the fine dust must travel downward close to the clean gas outlet where much of it escapes. Buell Cyclones have made an impressive record in many years of trouble-free service. To see how their extra efficiency in the Shave-Off can pay off for you, send for our Cyclone Catalog #103. The Buell Engineering Co., Inc., 123 William Street, New York 38, New York. Northern Blower Division, 6409 Barberton Avenue, Cleveland, Ohio. (Subsidiary: Ambuco Ltd., London, England.)

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CYCLONES • ELECTRIC PRECIPITATORS • BAG COLLECTORS • COMBINATION SYSTEMS • FANS • CLASSIFIERS

Quick Look at Industry...

First Suit Under Landrum-Griffin Act . . .

Labor Department files first suit under Landrum-Griffin Act to set aside union election. Defendent: Independent Petroleum Workers Union, Bayway, N. J. The Charge: Failure to provide proper safeguards for fair election.

Merging the Old and Forming the New . . .

Sunray Mid-Continent organizes wholly owned subsidiary, Sunray Chemical, to handle petrochemical and chemical research, sales and manufacturing . . . Enjay Chemical divides Chemicals Division into industrial chemicals and raw materials divisions . . . Shell International Chemical and National Distillers & Chemical form company, yet unnamed, to produce polyolefin film, plastic packaging materials.

Ike Urges Action on Fuels Tax . . .

Special message sent by President Eisenhower to Congress urging action on his tax proposals of last May. Of special interest to Ike: proper financing to avoid delays in interstate highway program—increase in aviation fuel tax to finance Airways Modernization program.

Scanning the New-Process Picture . . .

New liquid petroleum process recovers carbon disulfide from sulfur-rich petroleum fractions. Costs about 25% less in plant investment-15% less in production costs than present methane process. Advantages make installation of plants for captive production desirable . . . Scientific Design offers new fumaric flowsheet for small package plants. Process uses new catalyst—gets higher yields—is based on moderate isomerization conditions . . . Sohio process in pilot-plant stage catalytically converts propylene into acrolein at "costs substantially less than other methods." Process uses special bismuth-phosphorus-molybdenum catalyst.

New Way to make synthetic rubbers announced by Connecticut engineering firm, Crawford & Russel, which has process in pilot-plant stage. Based on elastomer-solvent system, method bypasses crumb-type coagulation of conventional emulsion processes. Advantages claimed: $500,000 savings on 30,000-pound-per-year plant, lower operating costs, and continuous,clean, easily controlled operation.

Explosion, Fire and Death . . .

Violent explosion racks Utah Oil Refining's Salt Lake City plant on August 19-followed by searing flames. Result: cat cracker damaged to tune of $250,000-two men on unit burn to death.

About Face for India . . .

India calls off deal to import Russian crude because of pressure from Caltex, Standard Vacuum and Burmah-Shell. All three told Indian government they would not refine crude from USSR. Bigger inducement: a 12% price cut to meet Soviet competition. Problems ahead: big exploration plans by Indian government, plans to build four government refineries in next five years.

Good News for Chem Engineering Majors . . .

Chemical engineering students who have jobs lined up just before graduation climb from 46% in spring of 1958 to 61% in 1960. So says 1960 Engineering Graduate Placement Survey of Engineering Manpower Commission. Survey covers 100 colleges, 15,000 engineering grads.

Casting an Eye Toward the Future . . .

Spencer Chemical completes first part of severe road-test program using flexible nylon tubing as gasoline carrier from gas tank to carburetor. Look for more use of material, which offers easy installation, can be used with standard fittings, need not be preformed, eliminates need for

flexible connections, and can be used at more than 100°F to less than -20°F.

Increased speed and horsepower will open tire-fiber market to polyvinyls, polyamides and polyesters as melting-point capacity necessary increases to 600°F.

Quick Look at World Wide Construction . . .

Esso Petroleum plans $15-million expansion of Fawley, England, petrochemical facilities— completion slated for end of 1961 . . . Petroleos Mexicanos to build $10-million tetraethyl lead plant in Mexico . . . Foster Grant eyes San Jacinto Battleground area of Texas as site for $5-million nylon plant . . . Union Carbide Australia to double capacity of Altona polyethylene plant to 30 million pounds a year . . . Bunawerke Huels ups synthetic rubber capacity at Marl, Germany, to 120,000 tons a year . . . More about construction on page 338.

Looking Over the Demand Scene . . .

Better balance of supply-demand seen for last part of 1960. Although demand growth not as great as forecast, supply-demand relationship expected to improve earnings in oil industry. Present picture: U.S. markets generally firm despite mid-August reductions of posted crude-oil prices in Middle East . . . increases in refinery prices of heating oils cheer suppliers . . . kerosine demand stays strong as jet-fuel use grows. More about demand on page 374.

Oil Second in Investigations . . .

Oil industry "probably ranks second" after food industry in investigation of monopoly and price discrimination, says Federal Trade Commission Chairman Earl Kintner. Investigations in oil industry have reached as high as 10% of agency's effort, more complaints being issued last year than 1948-53 period.

Cuba Shapes National Oil Monopoly . . .

Cuban Cabinet enacts law enabling Instituto Cubano de Petroleo to bring expropriated Esso, Sinclair and Texaco properties into integrated national oil monopoly. Institute will operate as division of National Agrarian Reform Institute. Meanwhile, technicians from Peru, Argentina, Guatemala and Mexico operate seized refineries.

Liquids Battle Grease and Grime . . .

Liquid detergents challenge powdered detergents for top spot among household cleaners. Sales this year expected to hit 620 million pounds, compared with 150 million a year ago. Dishwashing detergents should chalk up total sales of about 502 million pounds in 1960.

Fewer Workers—Less Throughput . . .

Gulf Oil cuts work force by 625 employes at 180,000-bpd Girard Point, Pa., plant. Throughput, which has been well below capacity for long time, is cut further to 120,000 bpd. Reason: "serious conditions of oversupply of crude and products."

Quick Look Around the World . . .

Cuban tanker rebuffed at Houston in attempts to get lube oil cargo. After lying off Galveston 10 days "Mar Caribe"Sailed for New Orleans. But generally, Cuba having no trouble getting tankers or cargoes—so U.S. tanker squeeze may be in vain . . . OCAW asks for federal investigation into plans by Shell and Standard of B. C. to lay off some refinery employes . . . USSR trade officials say Russian exports of crude and products in 1959 increased 7.23 million metric tons over 1958—imports remained steady . . . Sonneborn Chemical & Refining sold to Witco Chemical for 300,000 shares of Witco stock . . . Shell develops low-temperature fuel cell that uses hydrogen and oxygen as fuel—is considering use of other fuels for cell, including hydrocarbons . . . USSR negotiating with Japan for lease or purchase of cargo ships. A number of Japanese shipyards submit proposals.

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B&W *Job-Matched stainless steel tubing*

B&W's complete range of sizes, grades and types of stainless steel pressure tubing provides you with . . .

- the choice of a specific tube which best meets a given set of service conditions
- the choice of a combination of diameter and wall thickness for any type of operating requirement
- fully annealed tubing for maximum resistance to corrosion

The availability of *the best tube for the job* is only one of the reasons why it pays to specify B&W Job-Matched Stainless Steel Tubing. It permits freedom of design, and optimum low cost as well as long service life. Many sizes, grades and types of B&W Stainless Tubing are available through your local Steel Service Centers. For additional information call your regional B&W District Sales Office or write for Bulletin TB-1. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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For more data on advertised products, use Readers' Service Cards, last page.

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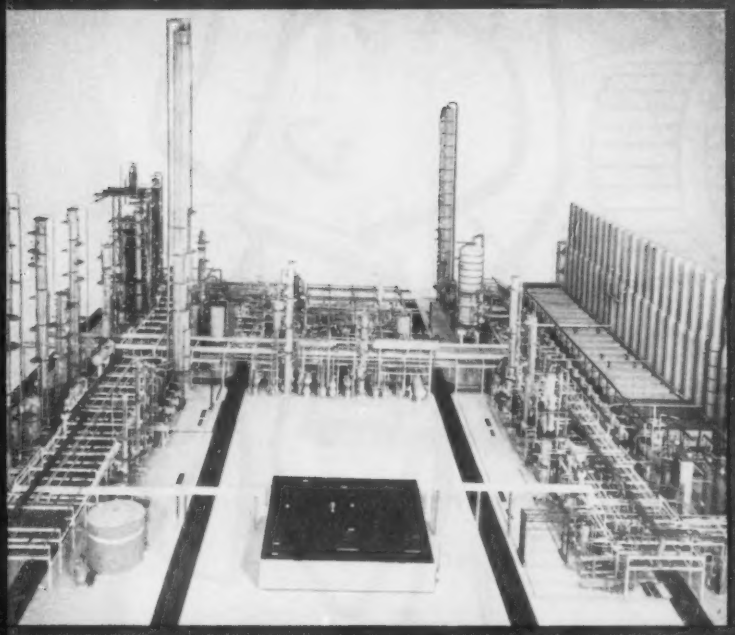

Mobil

FUTURE WORLD'S LARGEST is Socony Mobil Oil Company's ethylene plant at Beaumont, Texas. It is the first large plant in the U.S. to crack naphtha into olefins. Engineered by The M. W. Kellogg Company, as shown in this scale model, it is scheduled for completion by Kellogg by 1961. Capacity will be 380 million pounds annually of 99.9% purity ethylene.

This newest plant consists of steam pyrolysis, gas treating, and product recovery sections. It has been designed to handle simultaneously both liquid and gaseous feedstocks. In addition to ethylene, major products will include propylene, propane, a B-B product, gasoline, and fuel oil.

ICI

LARGEST OUTSIDE THE U.S. is the English Wilton Works of Imperial Chemical Industries, which now includes three olefin plants. Photograph shows Plant No. 3. All are the result of close engineering cooperation between Kellogg and I.C.I. Together, they represent a current output of 110,000 tons per year of high-purity ethylene, and a potential of 140,000 tons.

Plant No. 1, commissioned in 1951, was the first full-scale adoption of the then novel process of oil pyrolysis developed in Kellogg's laboratories. Its success led to the addition of Plant No. 2 in 1956, and then to No. 3—representing a 60% increase in olefin capacity—in 1959.

Whether your approach to ethylene is through the steam pyrolysis of hydrocarbons or the recovery of ethylene from gas mixtures, Kellogg has developed processes which can assure the optimum investment, operating costs, product purity, and yield. For more information about Kellogg's 2-billion-pound background in engineering and/or building ethylene plants, write for a copy of "Olefin Plants" Kelloggram.

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No Push-Button Engineers Please!

EVERYWHERE ONE TURNS these days, he is faced with the onslaught of technological progress—that insatiable drive that compels us as an industry—as a nation—continually to do things better, faster, cheaper, more efficiently. And, there is certainly nothing wrong with this. After all, these things form the mold—the casting—of industrial America.

But sometimes it is wise to pause a moment amidst the forces of industrial competition to reflect on the one element therein that refuses to be measured, stereotyped or mechanized—human judgment.

Most of us have, at one time or another, been working diligently on a project, only to suddenly put our pencil down, lean back in the shair and wonder—not about *how* the job should be done but *why* it is being done. Upon close analysis—how often have we discovered that a project is being approached or handled on the basis of little increments of engineering data compiled into a sort of Frankenstein monster from which we can't free ourselves?

In other words, statistics appear to be dictating the job's method and outcome. But, in fact, isn't man the most diversified, the most highly developed, the most complex bundle of statistics and mechanical ingenuity available? It is then, really a question of which came first, chicken or egg, individuality or cold statistics? Man can utilize his creativity—his human judgment—in applying mathematics, physics, and the other tools of his trade—or he can instead be a slave to the physical—the mechanical—that is, do it only with a slide rule, without thinking the problem through creatively.

At this point, he becomes a device or instrument much like those which he should be *using* to reach a given end. Human judgment—the one factor in the known universe that transcends mechanization—is eliminated from the picture—and the engineer is left wallowing in his own equations.

Can it be that math and statistical techniques have relieved us of the necessity for human judgment? If so, our industry and nation are in real trouble—for it is such insistance upon complete conformity and uniformity which, on the political side of the fence, leads down the road to socialism and communism. The industrial counterpart of these two governmental evils would be a thesis something like this: "Do it only by the book. If it can't be measured, analyzed, computed or tested—forget it. Let the *plan* take care of itself. After all, hasn't it worked in the past?"

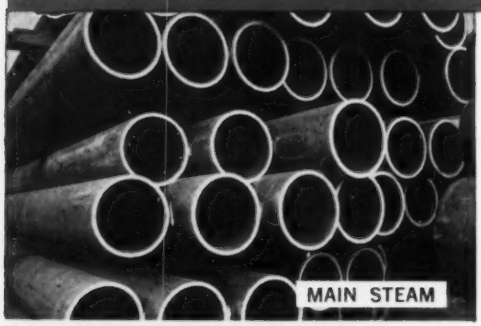
Henry B. du Pont, a vice president, director and member of the Executive Committee, E. I. du Pont de Nemours & Co., pointed out in a recent address that "technology abounds with temptations. Because it is easy to ride, we hesitate to walk. Because we can employ tools, we forget they were fashioned to aid, not to replace, the human mind. Because we can reach far into the sky, we overlook the fact that our roots and responsibilities are here, deep in the earth. Too many of us . . . rely upon our calculators and our mathematical formulae to chart our course in advance, to prove our case before trial, and to insulate us, in fact, against all risk."

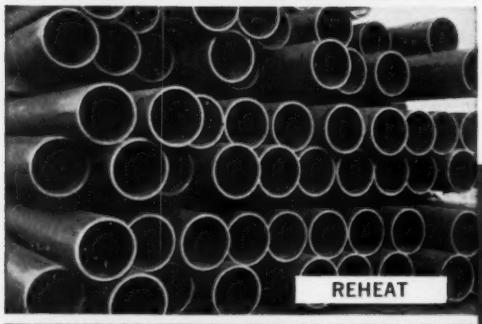
Too often we use the traditional proven way of doing things to excuse ourselves from applying fresh thought and meditation to a challenging job. We are like the man who, while changing a tire in front of an insane asylum, discovered that he had lost his lug bolts. An inmate called from a nearby window, "why don't you take one bolt from each of the remaining three wheels—then you can replace your wheel and drive on?" The amazed motorist, impressed by the inmate's ingenuity, replied, "Say, what are *you* doing in there?" The inmate replied, "I'm in here for being crazy, not for being stupid."

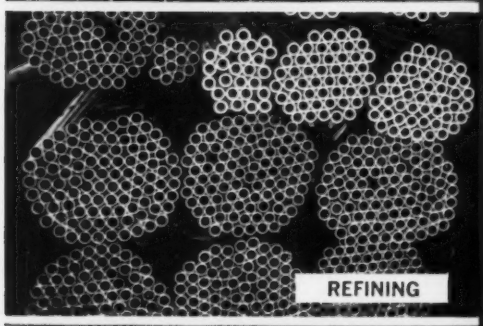
This motorist was hemmed in by stereotyped thinking and tradition. He had no lug bolts, and you can't drive a car on three wheels—an impossible situation. What he lacked was the human judgment factor which the inmate had retained even though mentally unbalanced.

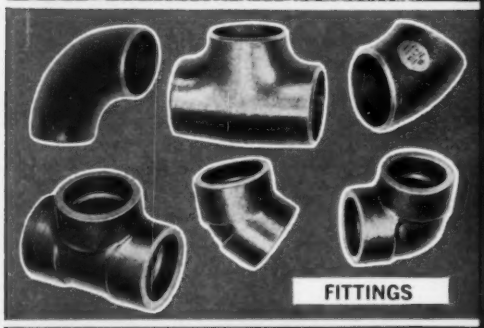
Engineers and scientists often seek to apply empirical, objective means and methods to areas in which science is like a fish out of water. When traditional technical approaches are applied to a problem, far too often we find that, by the time decisions and preparations are completed, conditions have changed and the plan bogs down.

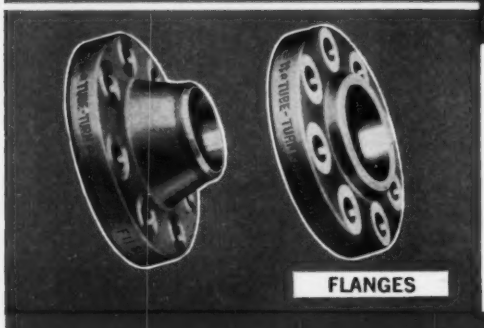
The real problem then, is to understand technology for what it is—neither undervaluating nor overvaluating its importance. It is management's responsibility to encourage the human judgment factor, and thus eliminate the "push button" engineer who dares not venture beyond anything that conforms to established precedent. Today's fast-paced technical progress accentuates the pattern of conformity increasingly











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Shown at left are some of the many special Alloy products carried in inventory.

MAIN STEAM: 8⅝" O.D. through 14" O.D. heavy wall in 1¼% and 2¼% chrome. Also the complete range of Schedule 160 and Double Extra Heavy Walls ½" ips to 8" ips.

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pervading the industry at large.

With computers and other far reaching developments leading to increased automation much of what was once in the realm of human judgment is now mechanical. But it is this same automation that is leading to bigger, more productive industry, and with it comes the need for that same human judgment applied to different areas. It is in these areas that we must give more engineers the opportunity to make decisions and to base those decisions on their own evaluations.

Highway Taxes or Highway Robbery? CONGRESS in 1959, finally okayed a "temporary" one-cent hike in the federal gasoline tax. An agreement could not be reached on some other way of keeping the federal highway program out of the red and progressing smoothly. This fourth cent, the third addition to the federal rate since 1951, was tacked on last October 1.

Thus the over-all national average of state and federal taxes reached more than 10 cents a gallon. These combined taxes currently amount to 48 percent of the regular-grade gasoline retail price, soak up 62 percent of the wholesale price and 85 percent of the refinery price. In 20 states, taxes amount to more than one-half of the retail price of gasoline, and in some areas actually *equal* the refinery price.

The latest increase Uncle Sam called a temporary one—to expire next June 30. It was part of a compromise agreement under which other auto excise taxes were to be used for the highway program when the temporary increase expires. The bill, without this condition, would never have been voted. So if Congress does an about-face on this arrangement in 1961, it would be displaying astonishingly bad faith toward highway users. However, strong pressures likely will be exerted to continue the "temporary" toll.

The pattern of things to come is obvious and ugly. Unless our industry and other American citizens themselves exert some pressure on Washington's semi-socialist element, which would hoist the gasoline tax even higher, there will bo no relief. In fact they would add even further levies on gasoline.

Unquestionably the federal gasoline tax should be re-established at three cents on schedule at midnight, June 30, 1960. The factors are these:

- The federal gasoline tax supports about 85 percent of the gigantic federal highway program.
- The American motorist, saddled with a four-cent levy to pay the bulk of the highway program's cost, shells out $1.5 billion per year in special auto taxes *not* being used for highways.
- Part of the cost of highways should be met from general revenues because highway benefits go far beyond use of the road itself.
- The weight of these taxes, nearly 50 percent of gasoline's retail price, is too much for the American motorist to bear. To lift the burden even a little, Congress *must* let the federal levy return to three cents per gallon.

"Just Spend A Day There—" MOST AMERICANS got somewhat fed up years ago on word and other sort of "inside Russia," pictures that showed how much better off we are than those peoples behind the Iron Curtain. In numbers and frequency they were such as to make quite an impact at the time. Example: the Russian filling station snapshot that made the rounds, doubled and redoubled, a few years back.

Sputniks, Castro, U-2, Lumumba, and now Belka and Strelka have hit the headlines in the meantime and with such a rush that the plight of those living under the Khrushchev shadow has been a topic somewhat neglected of late.

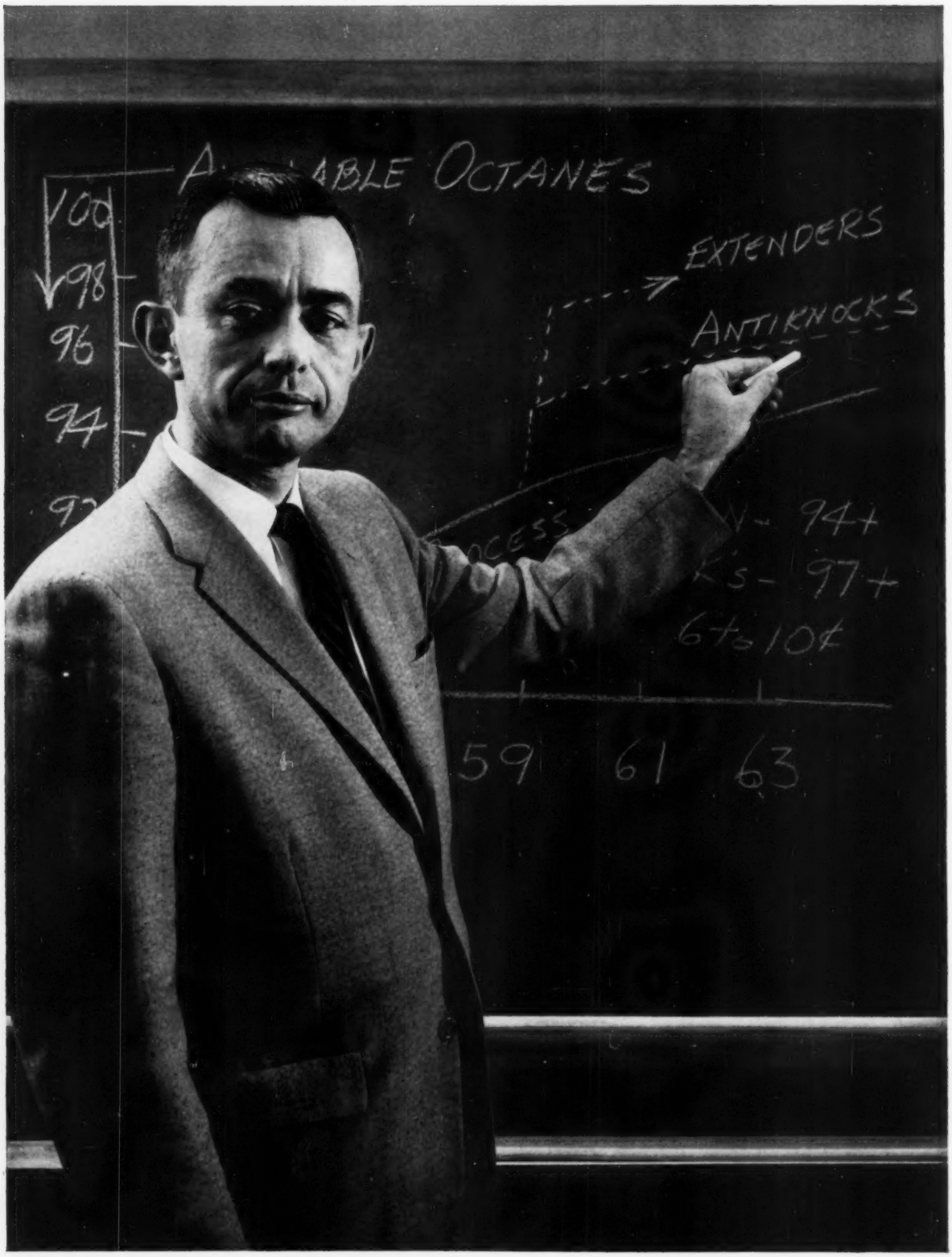
All of which thoughts came to mind when a few days back we read in *The Esso Research and Engineering News* an account of Harry Crawford's impressions of Moscow. Mr. Crawford, of Esso's General Engineering, was a delegate to the first international congress of the International Federation of Automatic Control. View these vignettes:

> Best one-word description is "uncomfortable," not in the sense of physical discomfort but, rather an inability to feel at ease.
>
> "I was followed during the first and last days of my visit and my room (in Hotel Ukraina, one of Moscow's best) was searched several times."
>
> "A teenager offered me the equivalent of $230 for the suit I was wearing and when I declined, he said he'd throw in a 17th-century painting."
>
> Delegates to the congress (from 25 countries) did not have full freedom of travel in Moscow, not because of military secrets but "it's just that they want you to see only the things they're proud of, not their slums and other depressed areas."
>
> "The people seem eager to talk with Americans, but usually become silent and move away when one of their countrymen passes. You can sense their fear. And it's not fear of Americans—they seem to be more afraid of their own neighbors."
>
> "Average high school students can 'earn' the right to attend Moscow University by working on a collective farm for two years."
>
> "All the manual labor I saw, from building a swimming pool in one of Moscow's parks to patching holes in the road, was being done by women."
>
> "Prices are extremely high. Small scarves, wanted for souvenirs, were about the cheapest item in the state store and yet they cost more than $5 a piece."
>
> "In grocery shops, you have to stand in line before each item you want, get a ticket for that item, stand in another line to pay for it, then go back to the first line and stand there to pick up your purchase."

In most circles Engineering Crawford's simple summation should cause little debate. And it is set down here not that it is so unusual but because Americans need to be jolted from time to time so they will realize the value of their extraordinary privileges. In this regard no one's views are as authentic as those who have seen the other side of the coin. Here's how the Esso man said it:

Anyone who doubts the worth of our form of government should spend just one day there.

"Never before have the octanes offered



by additives been so important..."

T. W. Warren, Ethyl's Director of Refinery Technology, discusses how you can save by using the "additive octane" route.

"ADDITIVE OCTANES" are important in planning the most economical means for producing fuels to satisfy today's cars. And now is the time to study new additive potentials as you plan for the future. Antiknocks and extenders can supplement existing processing flexibility and provide a well protected but economical timetable for your product needs.

Additives an economical buy

However you control your quality—on a Research, Motor or Road octane basis—*antiknocks are the least expensive way to increase quality on a cost per octane basis* in nearly every refinery situation.

Furthermore, if lead is used to increase antiknock quality as measured by Research method, there is a substantial Road octane bonus as measured by current rating methods. Only antiknocks give this Road octane "extra."

Additives versus capital investment

Antiknocks have long provided refiners with the ability to meet needed octane increases almost overnight. That protection is greater now than in the past.

For the foreseeable future, the refining industry can meet all octane requirements with currently installed equipment and the additives now available. The need for capital investment may be delayed indefinitely, since "additive octanes" will provide a well-protected but economical cushion if there is a need for octane increases.

For premium grade fuels, antiknocks and extenders already available and others being developed—together with increases in octane available from installed processing equipment—assure you of ample quality for many years to come.

For regular grade fuels, the use of maximum TEL offers even greater protection. Additional octane quality is available from Ethyl's new antiknock compound, Motor 33 Mix. To this can be added quality improvement available from existing processing.

What about the future?

Research continues in the "additive octane" field. The future is certain to provide even greater choice and flexibility for the refiner.

For example, antiknocks are now being developed which may be used to great advantage in special applications to improve road performance. Several TEL extenders are also being studied. Some of these will eventually be commercially available.

Before you consider building new process equipment, we invite you to discuss with our technologists how "additive octanes" can be your best buy. Such a discussion may lead you to postpone additional capital investment in equipment for a long time. Call or write your Ethyl Representative to get all the details.

ETHYL® ANTIKNOCK COMPOUND — ETHYL CORPORATION

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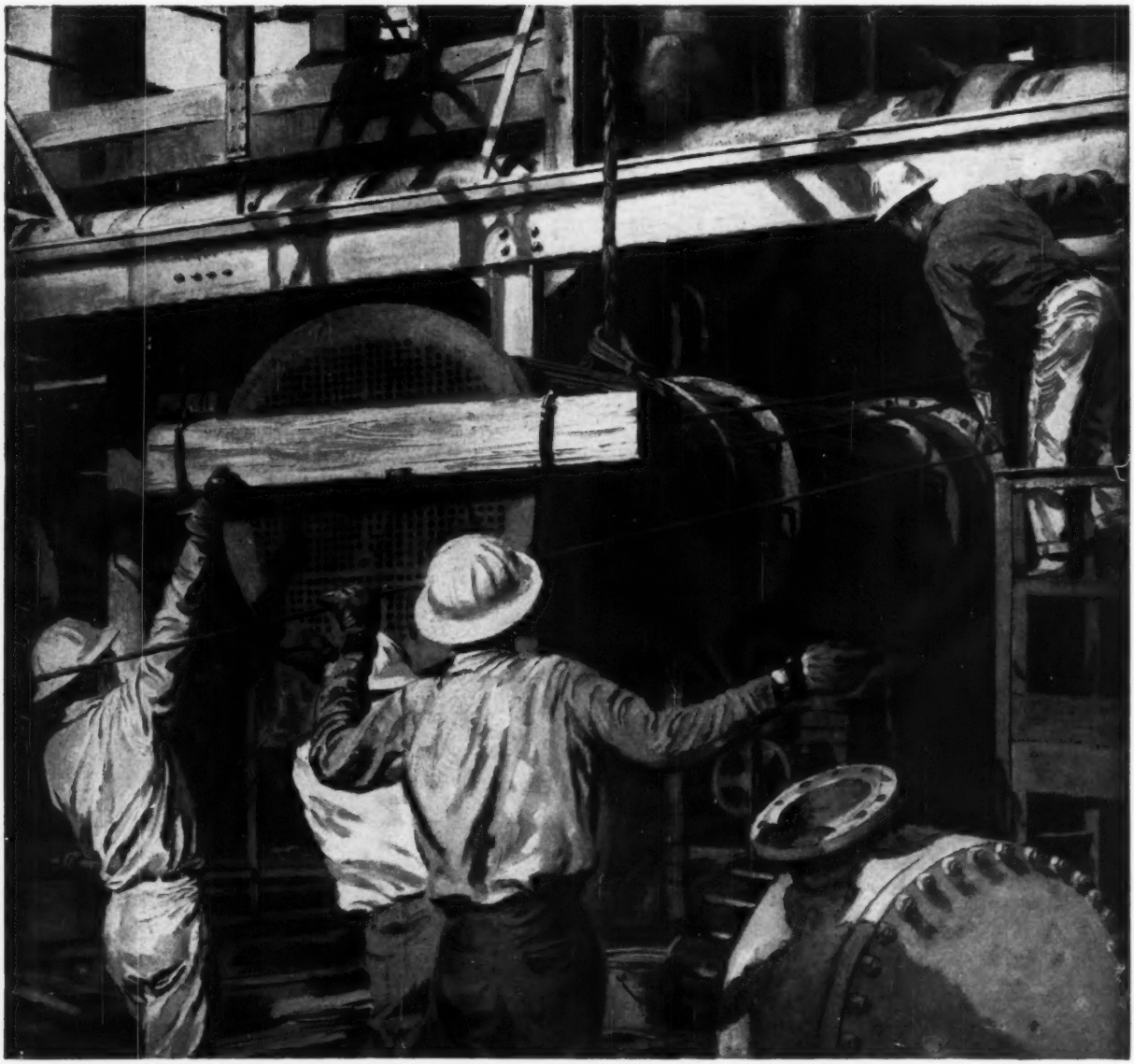

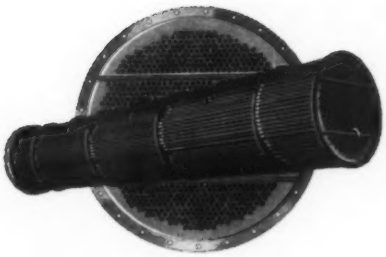

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Aeromaster
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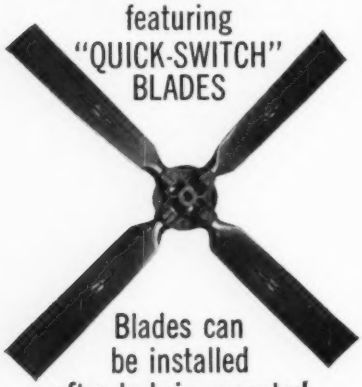

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Performance, construction, and price make this the "best buy" in industrial fans! Delivers more CFM with *less* H.P. Features a ductile iron hub, removable blade retention caps, heat treated aluminum alloy blades with constant chord width and flanged ends. 4, 6 and 8 bladed fans available in 54" to 120" diameters. Maximum tip speed is 15,000 ft./min. Easy to install . . . easy to maintain. For complete details, write: KOPPERS COMPANY, INC., 5109 Scott Street, Baltimore 3, Md.

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INDUSTRY QUIZ

Test your industrial IQ with this quiz on the current issue of PETROLEUM REFINER

1. Thermal cracking units now represent only 10% of the total U.S. cracking capacity in operation. True or False?

2. The primary purpose of catalytic cracking is to yield a higher octane gasoline blending stock. True or False?

3. Two stage catalytic cracking takes advantage of short-contact-time cracking to produce gasoline from the less refractory material. True or False?

4. Coking is a form of cracking. True or False?

5. With our present catalytic reformers, about how much gasoline production can be reformate:

(a) 35%
(b) 40%
(c) 50%

6. The predominant reaction in catalytic reforming is the conversion of naphthenes to aromatics. True or False?

7. What unleaded F-1 octane rating can be expected from alkylate:

(a) 95
(b) 100
(c) 110

8. The greatest use of isomerization is for making isobutane for alkylation unit feed. True or False?

9. Most refiners have found it worthwhile to install separate plants which crack methane and other light materials to produce hydrogen for hydrodesulfurization processes. True or False?

10. Most crude oils are contaminated with salt water, either in emulsion with the oil or in free form. True or False?

11. Which of these treating processes uses an additive in the caustic washing step to remove hydrogen sulfide and mercaptans:

(a) Dualayer
(b) Girbotol
(c) Solutizer
(d) Mercapsol

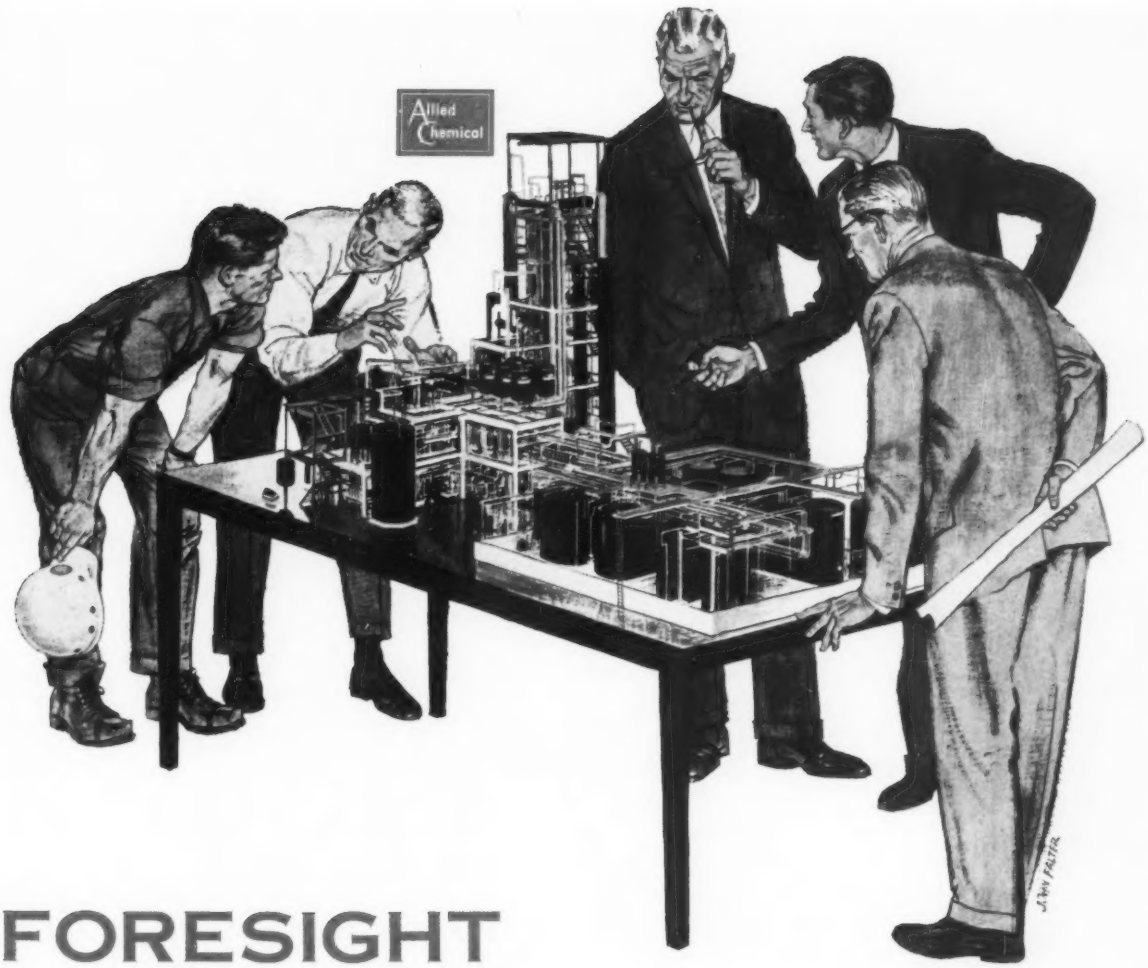
12. By the use of unsupported phosphoric acid as a catalyst in polymerization, it's now possible to replace the spent catalyst without plant shutdown. True or False?

13. A structural designer can pick a foundation from a capacity table as easily as a mechanical designer selects a storage tank. True or False?

14. Which data are essential for a plant estimator's use in determining centrifugal pump cost?

(a) pump volume
(b) total dynamic head
(c) horsepower
(d) material of construction
(e) special seals
(f) coupling type
(g) motor manufacturer

Answers on Page 368



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To accelerate and substantiate engineering and construction schedules...

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To train eventual plant operators...thereby reducing initial investment cost, CATALYTIC and client personnel study a pre-construction model of the phenol expansion at Philadelphia for the PLASTICS AND COAL CHEMICALS DIVISION of Allied Chemical Corporation.

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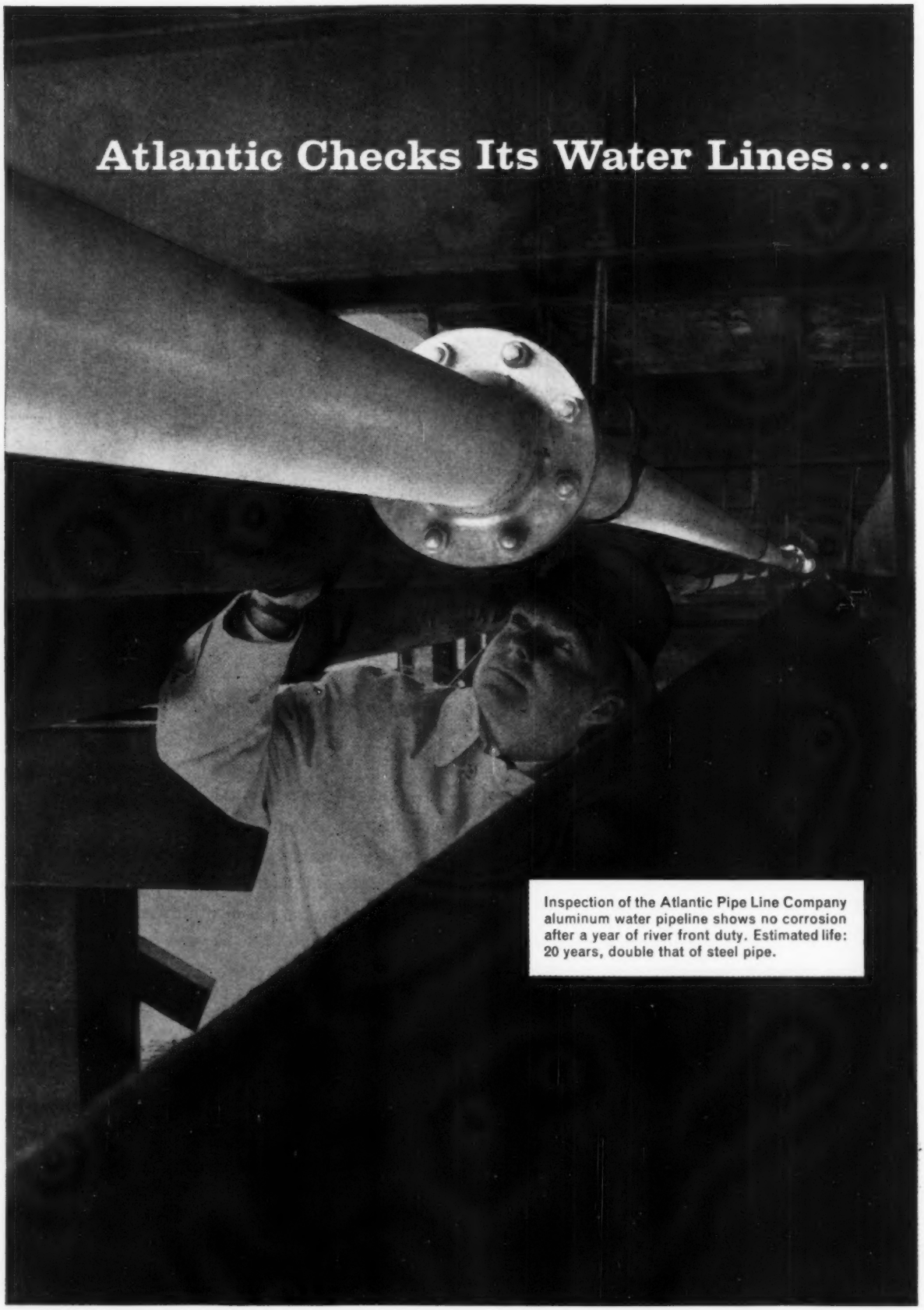
Atlantic Checks Its Water Lines...
Inspection of the Atlantic Pipe Line Company aluminum water pipeline shows no corrosion after a year of river front duty. Estimated life: 20 years, double that of steel pipe.

...and estimates aluminum process pipe will last twice as long as steel in dock duty!

Aluminum pipe stays bright, clean, and strong. It collects no scale inside, permitting use of smaller diameter pipe. Light weight simplified installation, eliminated need for hoist.

In November, 1958, the Atlantic Pipe Line Company installed an aluminum pipeline to supply water to ships and barges near Philadelphia. This was the first aluminum water line the company had used; it was Reynolds 4" Schedule 40 Pipe.

A year later, Atlantic checked the pipe, and judging from its condition, estimated its life to be 20 years or more. Steel pipe in the same service lasts about 10 years.

The extra longevity of aluminum process pipe in this service is just one of several advantages it has provided. Because aluminum pipe will not scale or collect corrosion products, Atlantic could use 4-inch pipe, compared to a 6-inch diameter needed with steel pipe.

Easy installation is another advantage with lightweight aluminum pipe. Atlantic's pipeline was fabricated in the shop, and just two men installed it working from a single barge. Hoisting equipment is necessary to install equal lengths of steel pipe.

Finally, Atlantic enjoys considerable savings in maintenance with the Reynolds Aluminum Process Pipe. Where steel pipe needs painting every few years for protection against spray, rust, and brackish water corrosion, aluminum needs none at all. After a year of carrying drinking water along the river front, the aluminum pipe line showed no exterior corrosion.

Add up the advantages: longer service, easier installation, less corrosion, less maintenance. When you consider all the long-term factors, you have to consider aluminum process pipe.

For details on aluminum process pipe, or aluminum for any process application, contact your local Reynolds office, *or write Reynolds Metals Company, P.O. Box 2346-CT, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

Watch Reynolds new TV show "Harrigan & Son", Fridays, starting October 7; also, "All Star Golf", Saturdays, resuming October 15—ABC-TV. And on Sunday, October 16, be sure to see the exclusive showing of America's new 1961 cars on The National Automobile Show, direct from Detroit over CBS-TV, 6 to 7 P.M. EDST.

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Investigate how bulk delivery of Tenamene additives can cut your gum inhibitor costs

Eastman's bulk handling system for Tenamene additives saves refiners a substantial amount of money.

In the case of Tenamene 2, the savings on a 36,000 pound tank car amounts to $2,160.

Smaller, but appreciable, savings can be realized through tank truck delivery, with the added advantage of 3-compartment shipment—permitting you to obtain in one delivery up to three Tenamene additives at a bulk shipment price.

Of course, not everyone can benefit from Eastman's bulk handling service. It's practical only for refiners whose inhibitor requirements justify modification or replacement of existing drum handling and storage facilities.

To help you evaluate the economics of a bulk handling system in your refinery operation, we have prepared a comprehensive engineering report that describes the fittings, transfer lines, storage installations and procedures required.

Your Eastman representative will be glad to demonstrate how a switch to bulk purchases of Tenamene additives can cut costs for you. Call him or write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

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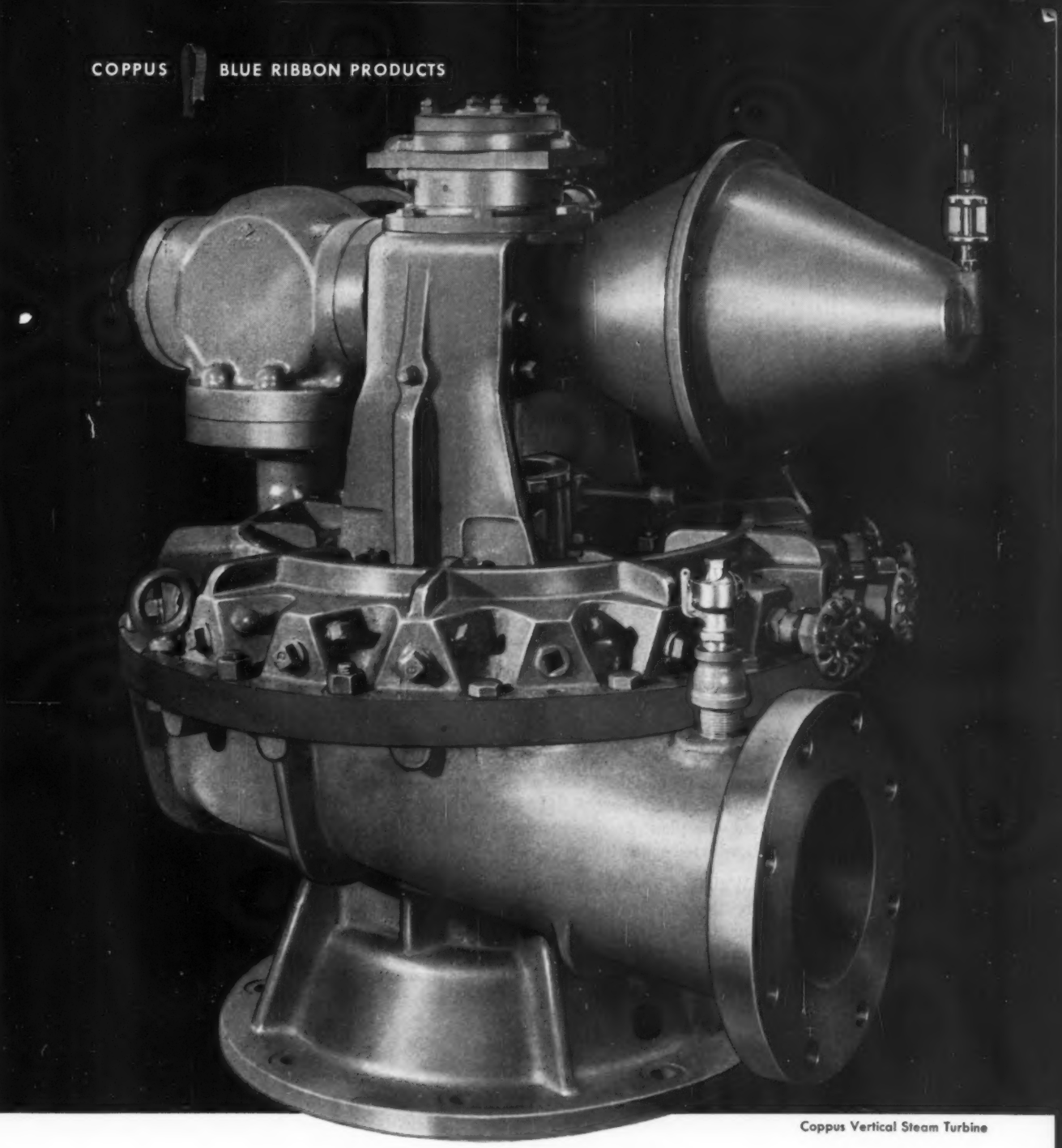

Coppus Vertical Steam Turbine

THE MARK OF QUALITY — There's no better test of a turbine's quality than performance. And the new, ruggedly designed, power-packed Coppus Turbines pass all performance tests with top honors! Small wonder. Coppus quality is literally designed and built into them. Their super stamina is the end-product of painstaking craftsmanship, finest materials and methods, thorough testing and control. Each truly deserves its Blue Ribbon . . . assurance of *complete* reliability.

Typical Coppus Blue Ribbon features are: *totally enclosed governor . . . totally enclosed and independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.* You get higher efficiency operation . . . less down time . . . lower maintenance costs.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. Send for Catalog 200. Get complete details on Coppus Turbines. Sizes from 1 HP to 250 HP. Write COPPUS ENGINEERING CORPORATION, 419 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

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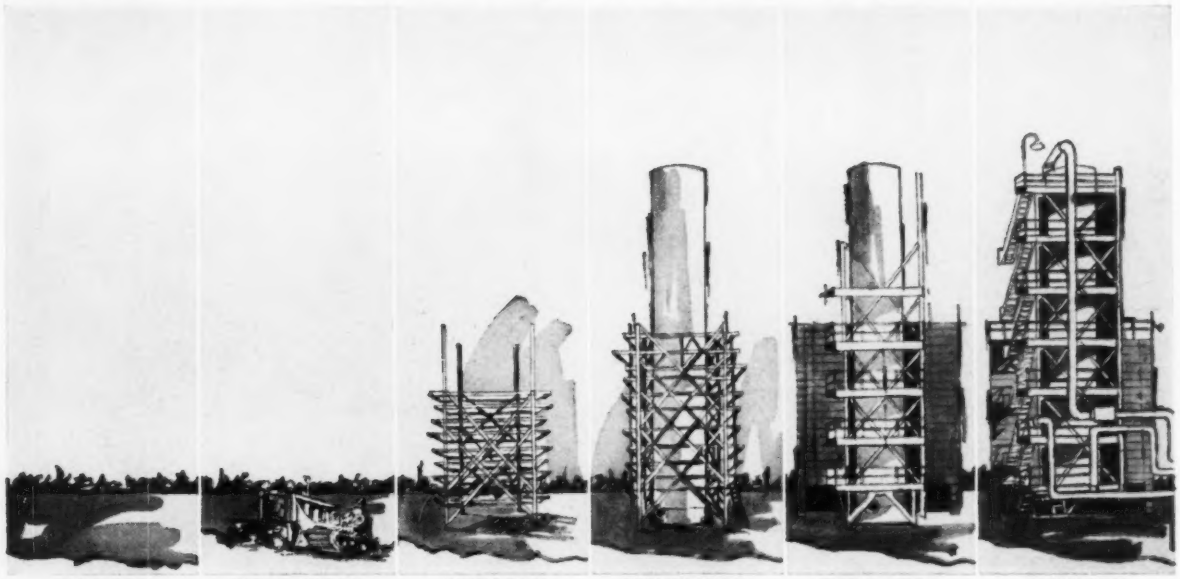
CHEMICO BUILDS NITRIC ACID PLANT IN SIX MONTHS



It took just six months for Chemico to successfully complete a 120 ton per day nitric acid plant in Lawrence, Kansas. Until the client gave his final "go-ahead," not an hour of drafting or engineering had been done on the project—not a single piece of equipment had been placed on order. Yet, six months from that date, the plant finished its acceptance test run, producing at above rated capacity.

With 34 nitric acid plants in operation all over the world, and three more in the design stages at this very time, Chemico maintains its position of leadership in this field. In building plants to produce Ammonia, Urea, Nitric Acid, Acetylene, Methanol, Hydrogen, Sulfuric Acid and other chemical and petrochemical products, Chemico is setting new standards for the entire engineering industry.

This six month performance for a nitric acid plant follows closely the recent successful completion of an ammonia plant in ten months. It is not just the time factor alone which sets Chemico plants apart, however. Chemico clients know that they are buying efficient, economical, proven processes which assure ease of start-up and simple, safe operation. If you are considering building a new plant or enlarging present process facilities, let Chemico help you get the most for the capital you invest. Write for the General Bulletin which describes the wide range of Chemico's activities.

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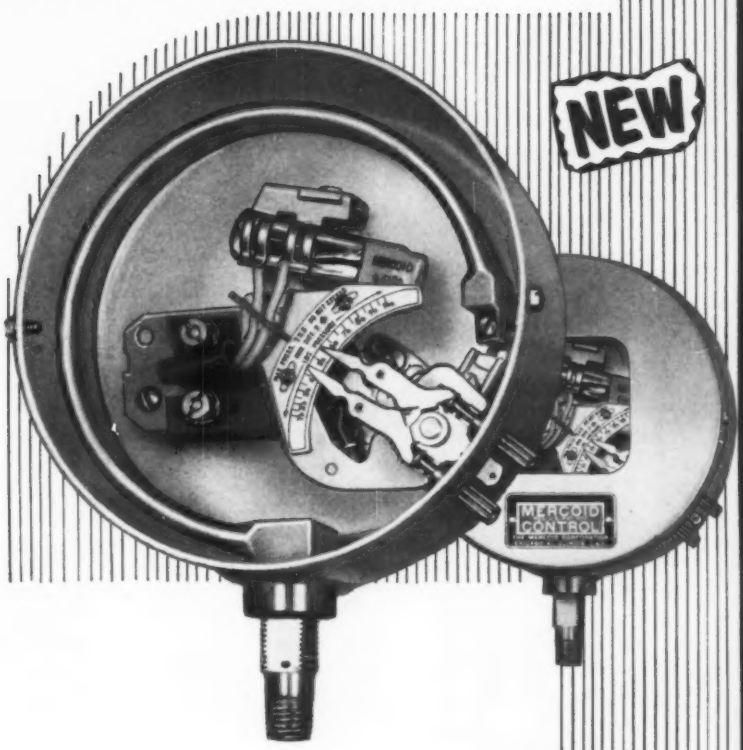
316 Stainless Pressure Connection

Nickel Plated Mechanism



SERIES D-41, D-541, D-243

- WELDED BOURDON TUBE CONSTRUCTION
- EXTERNAL ADJUSTMENTS
- SEALED MERCURY CONTACT
- VISIBLE ON-OFF CIRCUIT
- VISIBLE CALIBRATED DIAL

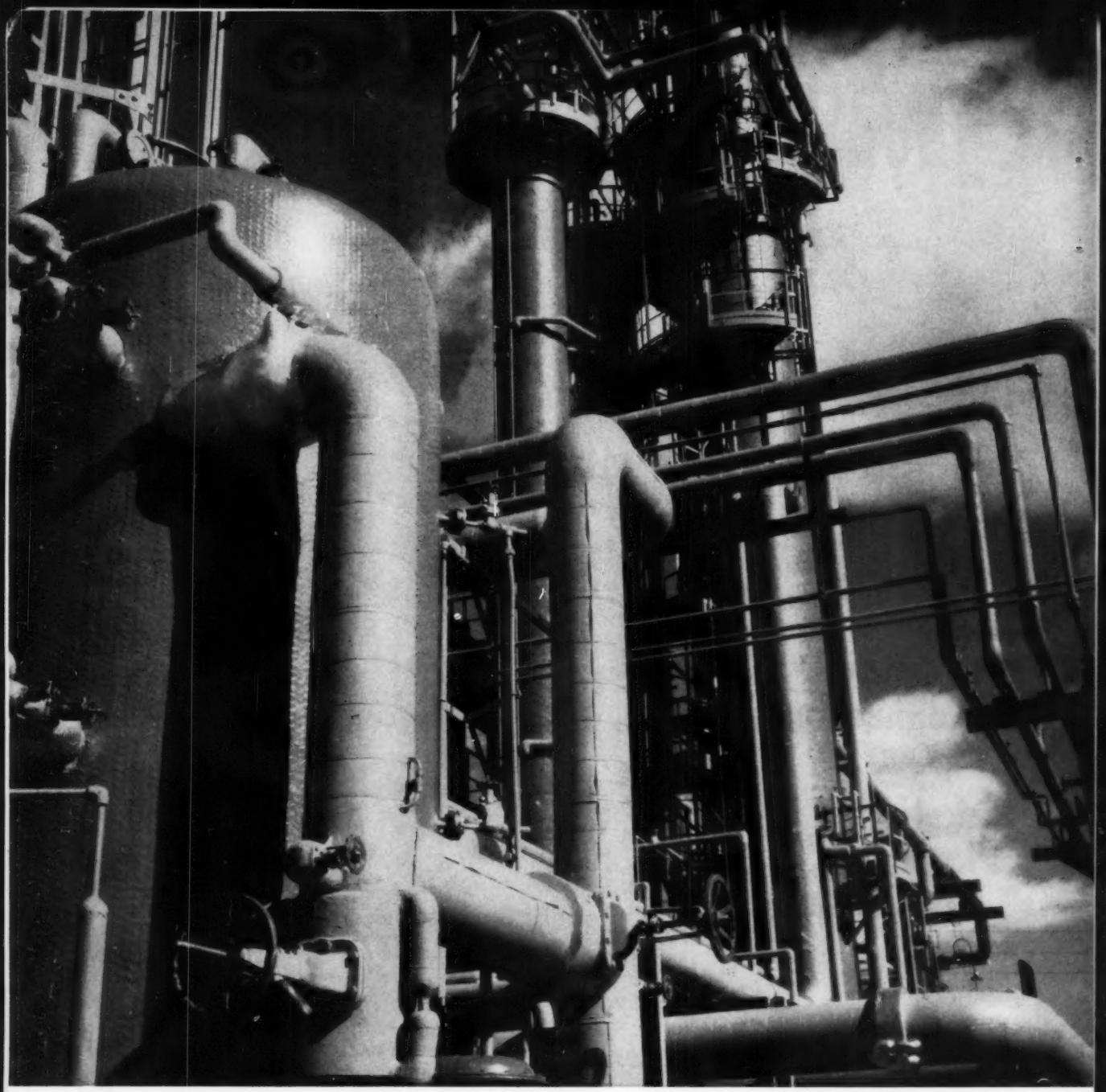
- AVAILABLE IN THREE CASE STYLES
- GENERAL PURPOSE NEMA 1
- WEATHER-PROOF NEMA 1A, 2, 3, 4
- EXPLOSION-PROOF NEMA 7, 9, 9A
- WRITE FOR BULLETIN 019

MERCOID CONTROL

THE MERCOID CORPORATION

4201 BELMONT AVE., CHICAGO 41, ILLINOIS

For more data on advertised products, use Readers' Service Cards, last page.



UNRULY UREA TOES THE LINE FOR 6 SOLID YEARS

Another demonstration of how well Aloyco Valves withstand the worst kind of corrosive conditions... many more years of service are expected. That's why engineers at Deere & Company's giant $20 million Oklahoma plant (went on stream in 1954) put many more Aloyco Valves to work. They buy performance. You'll find Aloyco Stainless Steel Valves in scores of processing plants, wherever severe conditions present difficult valve problems. Want to know more? Write: Alloy Steel Products Co., Inc., 1303 West Elizabeth Ave., Linden, New Jersey. 0.2

ALLOY STEEL PRODUCTS COMPANY

Boston • New York • Wilmington • Atlanta • Birmingham • Baton Rouge • Buffalo • Pittsburgh • Chicago • St. Louis • San Francisco • Los Angeles • Seattle

YOUR REFINERY WILL YIELD MORE WITH CYANAMID'S FLUID CRACKING CATALYST COMPOSITION

AEROCAT® 3C

THREE COMPONENT CATALYST

MORE GASOLINE OR MORE PROPYLENES, MORE BUTYLENES Cyanamid, in co-operation with a major oil company, has developed AEROCAT 3C—a new fluid cracking catalyst composition. AEROCAT 3C gives refiners more flexible and profitable operations and a greater yield at the expense of dry gas and coke. AEROCAT 3C-12 for increased gasoline yield. AEROCAT 3C-20 for increased propylene and butylene yields. **BASIC IN CATALYST CHEMISTRY**

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, N. Y.

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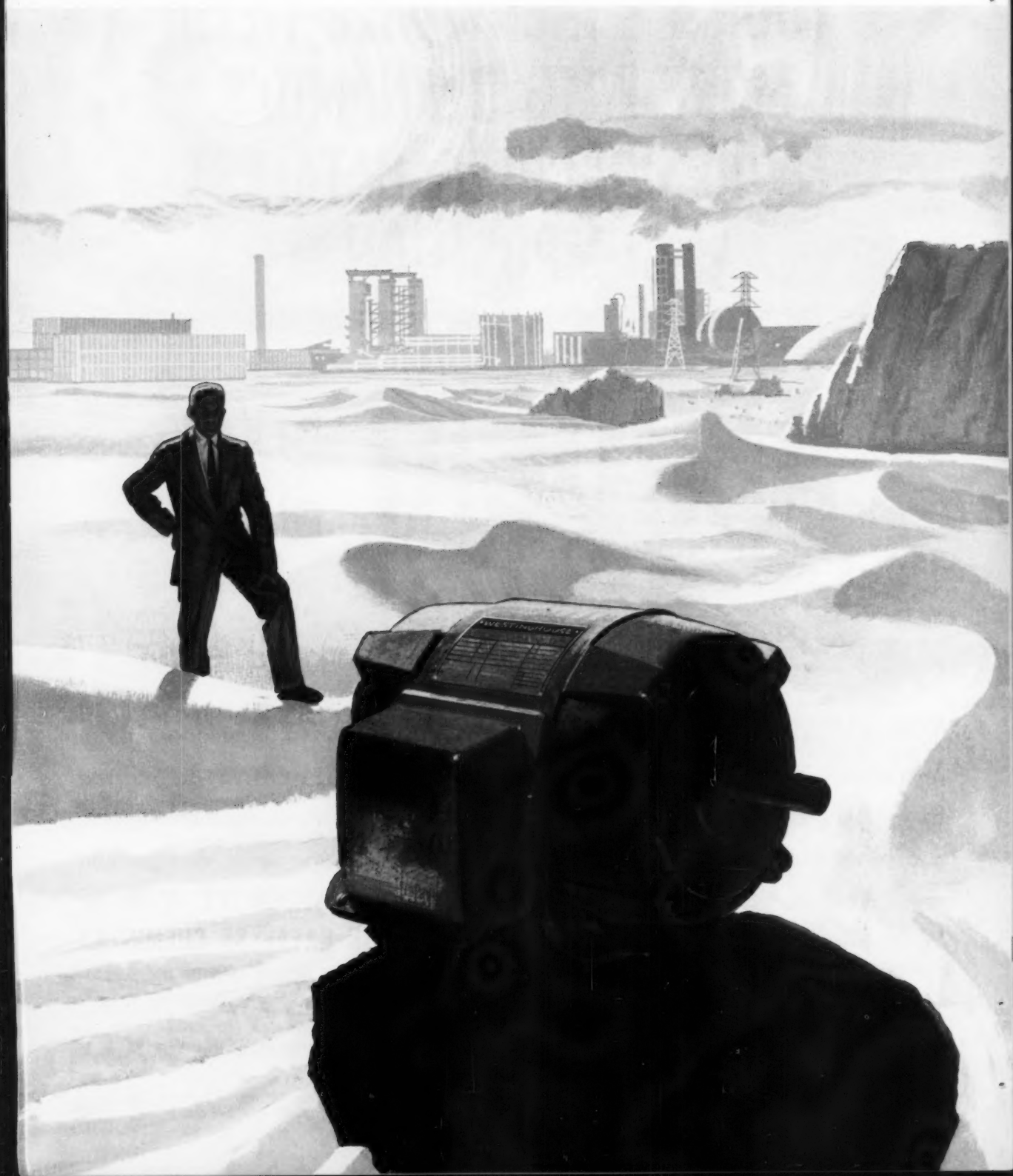
NEW WESTINGHOUSE *Guardistor*



MOTORS LET YOU USE ALL THE HORSEPOWER YOU PAY FOR...SAFELY

The man and the motors from Westinghouse now provide absolute protection against motor failure caused by excessive heat . . .

Our Engineering Manager says:
"With the breakthrough development of the Westinghouse Positive Temperature Coefficient thermistors, for the first time we can provide inherent protection against motor failure caused by excessive heat. The solid-state thermistors buried in the windings instantly sense excessive heat from any cause and simultaneously warn of trouble or automatically take the motor off the line. Thus, motor protection is placed where only true motor protection can be . . . in the windings."

Our Marketing Manager says:

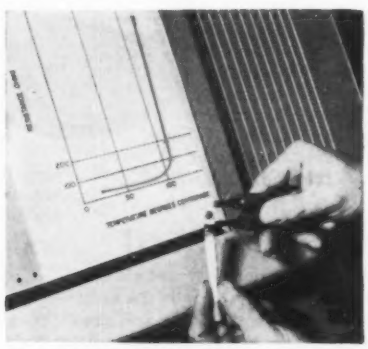
- "You can match the motor to the load . . . use all the motor you are paying for.
- Provides positive protection based on winding temperature . . . *not* load current and/or power supply fluctuations.
- Eliminates time and expense of changing winter-summer heaters. No nuisance tripping, it's fail-safe . . ."

Call your Mr. Westinghouse for the application of a Guardistor* motor to your drive requirements . . . write for *Questions and Answers About . . . Guardistor* (B-7876). Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

*Trade-Mark

J-22160-R

Unlike remotely located sensing devices, PTC thermistors are buried in the windings of the Guardistor motor, instantly equating all temperature factors.



Ever alert PTC thermistors constantly totalize temperature, statically triggering an action *only* if critical temperature is reached.

MOTOR & GEARING DEPARTMENT

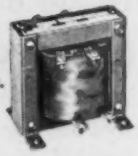
Westinghouse

SQUARE D SPIN TOP® ENCLOSURE NOW MORE VERSATILE THAN EVER!

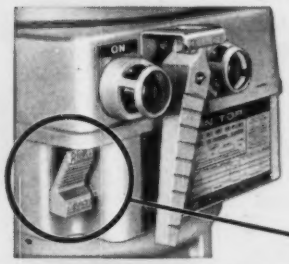
DAMAGE-RESISTING Acme threads. If you've struggled with "banged-up" threads, you'll appreciate this feature. It's always a breeze to put on and take off tanks for installation, inspection or maintenance.

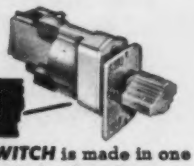
FULL WEATHER PROTECTION • Male threads on collar engage female threads on tank—no external threads to be damaged.

NEW! ***CONTROL TRANSFORMER*** can be mounted in collar. No special-length tanks required.



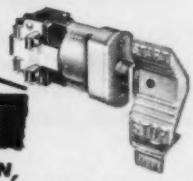
INCREASED WIRING SPACE • Four conduit openings standard, with through-feed conduit entrances for horizontal tap-offs optional.





NEW! ***SELECTOR SWITCH*** is made in one piece, installs simply by threading into opening provided in enclosure. One-piece construction permits pre-testing before shipment.

NEW! ***RECESSED CONTROL STATIONS*** like the reset button are out of the way, have no protrusion to break or bend accidentally.



NEW! ***PUSHBUTTON,*** like the selector switch, features one-piece construction for easy installation. Heavy-duty contacts and rugged mechanism assure long life.

NEW! ***BRILLIANT PILOT LIGHT*** is visible from all angles and provides easy bulb change. Enclosure available with either one or two factory-mounted lights or can be furnished with plugged holes for field installation. Stainless steel thread-in-thread construction gives corrosion-resistance and easy servicing.

EASY TO INSTALL with *slide and hook* mounting arrangement for interior equipment—a Square D "exclusive." Takes the hard work out of the installation job.

STRONG AND LIGHTWEIGHT construction. Complete enclosure is cast aluminum. All operating shafts are stainless steel, thread-in-thread, for the best in corrosion resistance.

Square D *is Better in So Many Ways!*

When you buy from Square D, you not only get all the benefits shown above—you also are buying from the only manufacturer who builds both the enclosure and the starter, giving you unit responsibility. Moreover, Square D offers better stocks, better on-the-spot service. That's why it makes sense to insist on Square D Spin Top enclosures for your hazardous location applications.

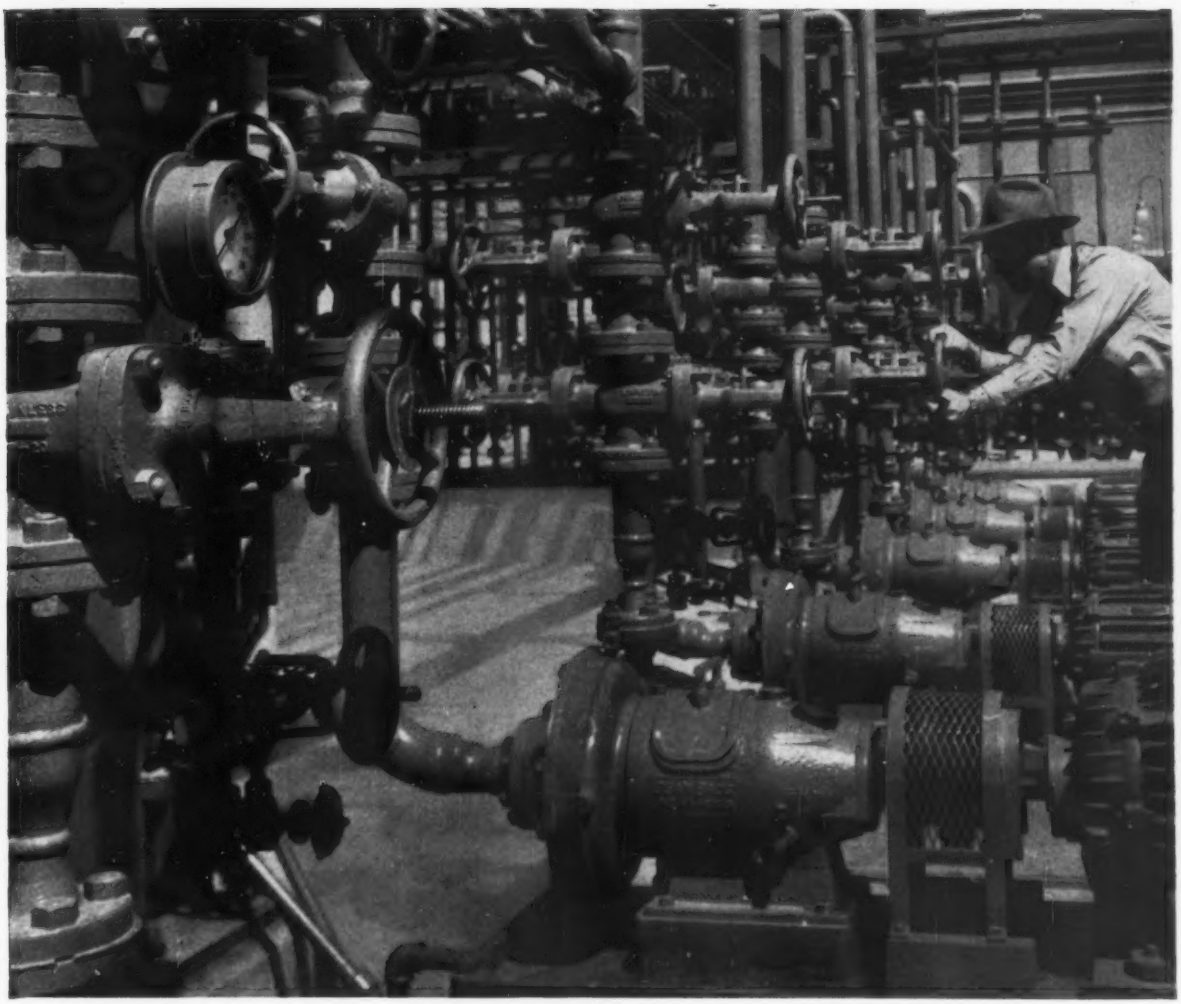
4 ENCLOSURE SIZES ACCOMMODATE NEMA SIZES 0 THROUGH 5

Square D Spin Top enclosures are NEMA 3 (weatherproof), NEMA 4 (watertight), NEMA 7 (explosion-proof) and NEMA 9 (hazardous locations) for Class I, Group C and D; and Class II, Groups E, F and G service.

Write for Bulletin 9990. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

SQUARE D COMPANY

wherever electricity is distributed and controlled



Ni-Resist irons: best "life insurance" yet for pump parts that live with H_2SO_4

Impellers cast from Ni-Resist* iron mean longer life for these pumps – moving a daily volume of concentrated sulfuric acid.

Maybe sulfuric acid isn't your problem. But if acids, alkalis or corrosive waters threaten your equipment, Ni-Resist irons may provide your answer.

With their high Nickel content and austenitic structure, Ni-Resist irons offer a unique combination of advantages:

They resist corrosion and erosion from high-velocity flow of caustics, chlorides, fatty acids . . . from corrosive slurries or wet steam.

They resist wear, extend effective life of valves, seals, impellers and other parts exposed to heat and metal-to-metal abrasion in corrosive media.

They reduce fabricating costs too, because Ni-Resist irons provide needed properties in economical *cast* form. Pipes, kettles, vessels, filter components and many other simple or complex shapes are produced at moderate cost, are easily machined and welded.

Get the full story of Ni-Resist irons in the 70-page booklet, "Engineering Properties and Applications of Ni-Resist Irons." 105 applications are described, and some may surprise you! Write today.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N.Y.

NI-RESIST

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

For more data on advertised products, use Readers' Service Cards, last page.

take NEWTHERM on test!

Test its STRENGTH

NEWTHERM is unusually strong and rigid—a feature of special importance in the larger, more vulnerable sections. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage. See how it withstands rough handling in transit and erection, minimising breakage in shipment and erection by unskilled labour at the most remote sites.

Test its MOISTURE RESISTANCE

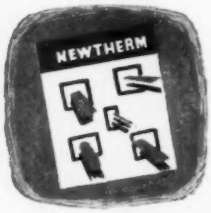
Even totally immersed in water, NEWTHERM retains much of its strength and rigidity. It does not become deformed when in contact with water, thus work-in-progress need not be covered. Especially on contracts where weather conditions would delay the application of insulation – NEWTHERM is the material to use.

Test its LIGHTNESS

Unusually light for such a high-efficiency material, NEWTHERM compares favourably in this respect with other insulants far inferior in strength. That means easier handling and fewer breakages—even the largest section is easily carried in one hand.

Test its EASE OF APPLICATION

Undoubtedly, NEWTHERM is one of the easiest of materials to apply. It is supplied in plastic form and in a wide range of standard-sized sections and slabs, smoothly finished and straight edged for immediate fitting. The finished job is very neat, with minimum joints, and appliers particularly appreciate the handleability of the material - especially in difficult situations.



READ ALL ABOUT NEWTHERM

in a specially prepared booklet. Sizes, compressive strength, thermal conductivity,—this and much more useful information can be on file if you write for your copy now, to the sole manufacturers Newalls Insulation Co. Ltd.

NEWALLS (Reg'd Brand)

***NEWTHERM** calcium silicate insulation*

. . . for temperatures up to 1400°F.

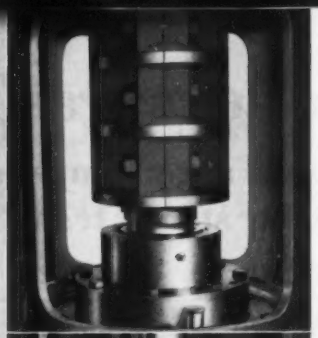
NEWALLS INSULATION CO. LTD.

Head Office: WASHINGTON, CO. DURHAM, ENGLAND.
A member of the TURNER & NEWALL ORGANISATION
Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.
Agents and Vendors in most markets abroad.

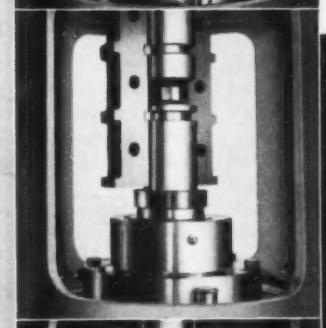
For more data on advertised products, use Readers' Service Cards, last page.

SIMPLY DO THIS!

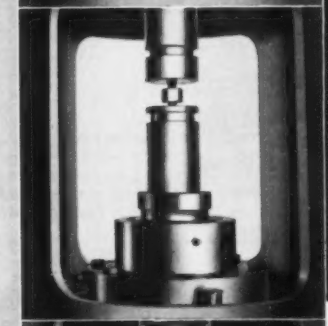
One easily assembled, self-aligning split sleeve coupling connects drive shaft and stirrer shaft.



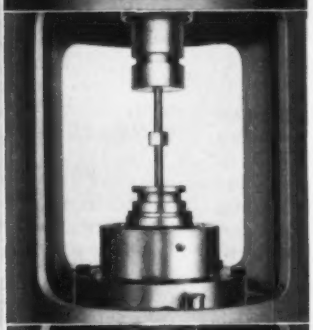
❶ Release sleeve collar set screws. Remove ½ of split sleeve coupling.



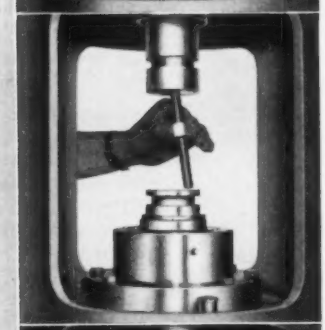
❷ Relieve shaft weight and remove remaining coupling half.



❸ Lower shaft on to support.

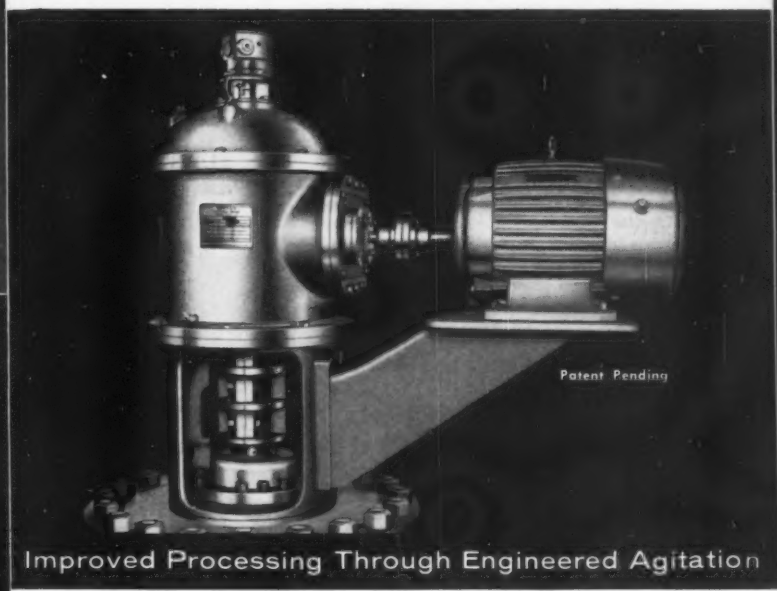


❹ Remove adjusting screw from opening.



❺ Unbolt and remove seal assembly. Reverse procedure to replace seal!

NEW! EASIEST, QUICKEST MECHANICAL SEAL CHANGE CUTS MIXER MAINTENANCE COSTS!



Improved Processing Through Engineered Agitation

A few turns of a wrench . . . and Nettco seal assemblies on tank top mixers can be changed quickly, efficiently . . . regardless of mixer size. Costly downtime eliminated! Design simplicity reduces initial cost! No special skills or equipment required!

DESIGN FEATURES

- No overhead lifting device required. Result: minimum overhead space needed . . . reduced maintenance labor and less downtime.
- Compact design with minimum distance between seals and drive bearings. Result: less shaft flexing at seals . . . reduced seal wear.
- Coupling jacks eliminated. Result: no working in cramped areas.
- No dismantling mixer . . . drive bearing untouched. Result: easier, faster seal maintenance . . . no bearing readjustment problems.

Nettco's Seal Replacement is easiest ever. For complete details, write for Bulletin 601 on your company letterhead. **Nettco Corporation, 81 Tileston St., Everett 49, Mass.**

NETTCO

ENGINEERED AGITATION SPECIALISTS

EVERETT 49, MASSACHUSETTS

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

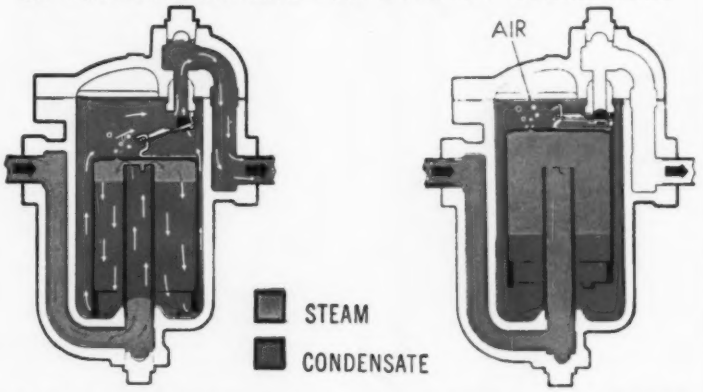
A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

See our catalog in Refinery Catalog

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8525 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS
813-ST

For more data on advertised products, use Readers' Service Cards, last page.

The customer who thought he got something special

A Gulf Coast oil refiner was in a hurry to build a new catalytic platformer. He needed a special analysis of seamless steel tubing—delivered from the mill in just the exact size and length. But, the refiner was afraid he wouldn't get the steel on time.

A team of Timken Company experts tackled the problem. They got the steel out on time—so fast that the refiner thought he received special treatment.

And he did—the very same special, individual treatment we're geared to give *every* customer—and do!

This order was routine for our team of metallurgical-production-operating people. Special jobs are right down their alley because they have the know-how and the facilities. You can call ours a tailored operation—but it's really more. The steel was babied all the way. Every modern quality control device kept an eye on the steel all through the melting, rolling, piercing, finishing. It passed every inspection for surface, size and quality and there wasn't a minute's delay. That's the kind of special treatment that's made the Timken Company a leading producer of special quality fine alloy steel.

If you want your steel to receive special treatment, give your next order to the Timken Company, where *every* order is special. And for help in solving your steel problem, consult our metallurgists. They've probably solved a problem similar to yours dozens of times.

The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.*

For more data on advertised products, use Readers' Service Cards, last page.

Refinery

Maintenance Made Simple

Here are the quality leaders, the names in refining, natural gasoline and petrochem plant equipment synonymous with performance.

When you specify pipe, valves or welding fittings made by these manufacturers, you know you are getting quality. You know that longer service life and less down time result when quality equipment is installed. We are proud to offer you these quality leaders. We know that the research and development invested in these products mean more satisfied customers for J&L.

You can have up-to-date literature on any of these products by calling your local J&L man.

Specify quality.... and save at J&L.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

108

NORWALK COMPANY, INC.

HIGH PRESSURE COMPRESSORS AIR and GAS

Almost 100 years, servicing world-wide industry with Quality, Dependability, and Safety

CUSTOM-PRODUCTION COMPRESSORS PROVED IN USE FOR EVERY INDUSTRY . . . FOR EVERY PURPOSE.

STAGES

From single stage to six stages:

Single stage	up to 125 psi pressure
Two stage	up to 500 psi pressure
Three stage	300 to 2250 psi pressure
Four stage	2000 to 6000 psi pressure
Five stage, Six stage	5000 to 42,000 psi pressure

AIR AND GASES

Full range of gases: acetylene, air, argon, specific hydro carbons, CO and CO_2, ethane, HCL, helium, hydrogen, nitrogen, nitrous oxide, oxygen.

VALVES

Low and high pressure reversible ring plate valves, conventionally located for quick removal. Low lift assures silent operation and increased, trouble-free life. Hand-lapped NORWALK valves used exclusively.

INTERCOOLERS

Shell and tube types used between 1st and 2nd stages; coil and tank types for high pressure intercoolers and aftercoolers. ASME rating upon request.

PISTONS

1st and 2nd stage pistons constructed in one casting, hollow in form to receive 3rd stage cylinder extension. 3rd and 4th stage pistons engineered of built-up construction.

PISTON RINGS

Sealing type used in 1st and 2nd stages; sealing type with follower or spacer rings in 3rd and 4th stage pistons.

LUBRICATION

Cylinders designed to be lubricated either by mechanical force-feed method, or by sight-fed positive pressure type lubricators.

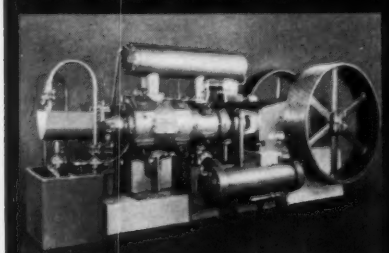
BEARINGS

Smaller size units with Timken single-roll roller bearings. Large size frames equipped with ¾ box type bearings. Both types lubricated with the splash system.

ECONOMY STANDARDIZATION

Interchangeable parts—cylinders, pistons, rings and valves—assure accuracy, maximum service and low-cost maintenance. The services of our Parts Dept. are available on a daily 24 hour basis.

Every Norwalk Compressor is ruggedly constructed and followed up with a factory test-run. Then, it is taken down for complete inspection before re-assembly and shipment.



Phone TEmple 8-4766 in South Norwalk for prompt consultation and information.
Detailed, descriptive Catalog 1960 available on request.

NORWALK COMPANY, INC. N. WATER ST., S. NORWALK, CONN.
Phone: TEmple 8-4766 • Cable: Ironworks

COMPRESSOR SPECIALISTS TO WORLD-WIDE INDUSTRY SINCE 1864

Low-cost IBM 1620 solves gasoline blending problem

DETERMINES WHICH COMBINATION WILL RETURN THE MOST PROFIT

The low-cost IBM 1620 Engineering Computer takes into account possible solutions to a blending problem and computes your most profitable operating plan.

The IBM 1620 prints out a complete description of its optimum solution, giving you the flow rates, unit severity levels and product compositions which should be used for the most profitable operation. Each variable in the system is accounted for, with complete cost ranges to indicate the sensitivity of your system to the initial cost and product data.

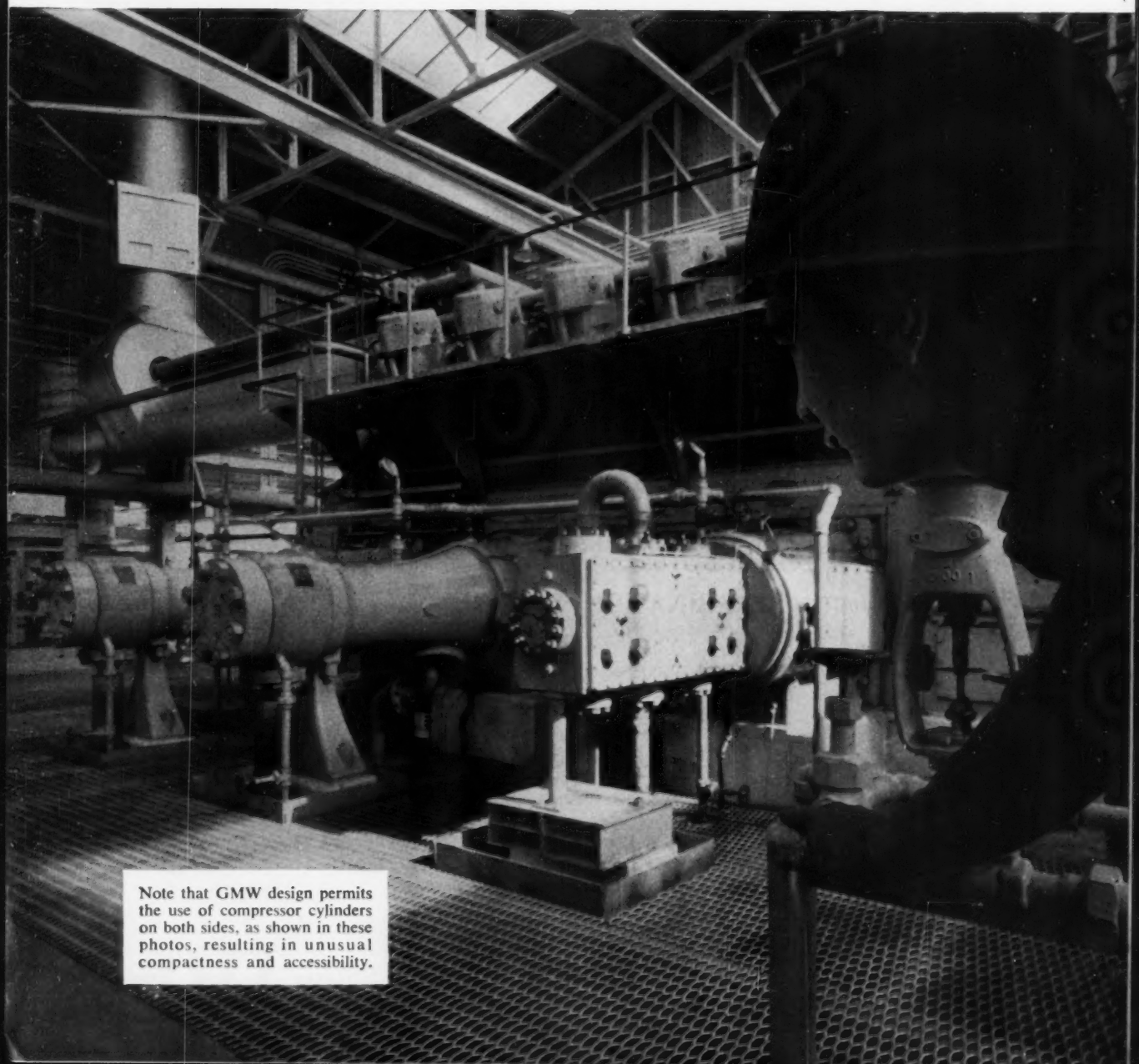
Using linear programming techniques, the 1620 adapts efficiently to changes in your system. These techniques will be made available without cost to IBM customers later this year. This is another example of Balanced Data Processing . . . machines supported by complete services. For information about the IBM 1620 and the special advantages it offers for blending and other important petroleum applications, call your local IBM representative. Like all IBM equipment, the 1620 computer may be purchased or leased.

THE IBM 1620 is an economical, desk-size engineering computer with features previously found only in larger systems. It offers solid state design, magnetic core storage and high-speed internal computing performance. Its versatility and ease of operation recommend it for such petroleum industry applications as distillation problems, unit correlations, evaluation of options and determination of equipment efficiency.

BALANCED DATA PROCESSING **IBM**®

Report from American Cyanamid, Fortier Plant...

How Cooper-Bessemer gas engine boost synthesis gas for ammonia



Note that GMW design permits the use of compressor cylinders on both sides, as shown in these photos, resulting in unusual compactness and accessibility.

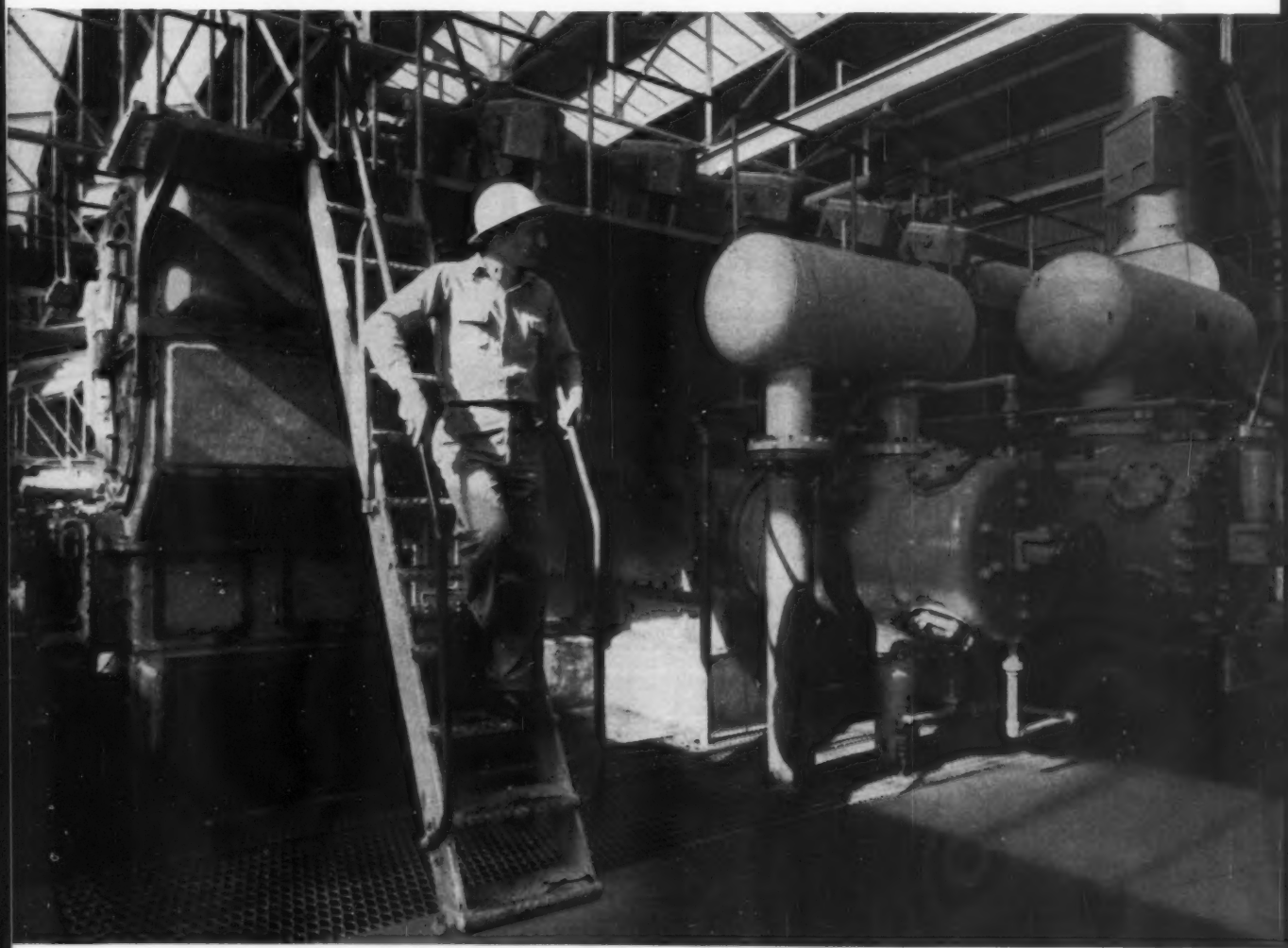
compressors to 5000 psi

These photos show both sides of one of the two Cooper-Bessemer 2500 hp GMW gas engine compressors at the Fortier Plant of American Cyanamid Company, Avondale, Louisiana. In the production of anhydrous ammonia, these 4-stage units compress 6000 cfm of synthesis gas from 60 psi to a discharge of 5000 psi. The left-hand view shows the high pressure cylinders; that on the right shows the low pressure side. The four stages of compression from 60 psi are (1) to 225 psi, (2) to 670 psi, (3) to 1500 psi, (4) to 5000 psi.

The two units have been operating since 1954, 24 hours a day, 340 days a year.

The anhydrous ammonia produced at the Fortier Plant is used by American Cyanamid in the manufacture of Acrylonitrile and is sold to fertilizer plants and other chemical companies.

Find out how Cooper-Bessemer can help *you* plan compression and power facilities. Write for copy of bulletin, "Cooper-Bessemer Equipment for Chemical Plants."



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Eagle-Picher ONE-COTE goes on in one single coat to the desired thickness . . . *does three jobs*—all in one quick and easy application . . . insulates . . . protects . . . finishes. Saves time, work and money! Effective for temperatures up to 1000 F.

For outdoor installations, Eagle-Picher One-Cote is quick-setting, withstands rain and moisture two hours after application. Contains a special rust-inhibitor to prevent rust. When used indoors, One-Cote requires no wire mesh or finishing treatment!

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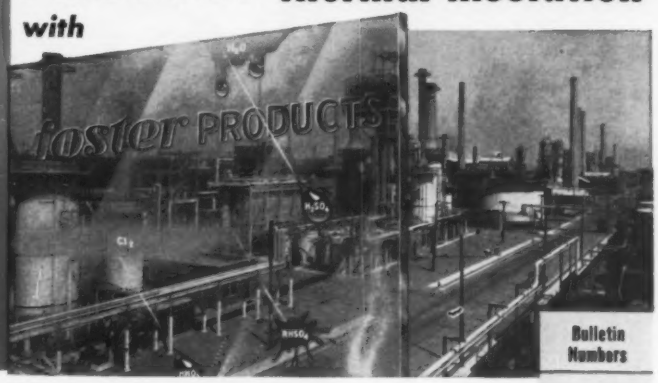

				Bulletin Numbers
mastics	60-24	CORK-FILLED MASTIC	Insulating mastic for storage tanks	M-3-B
	60-25/26	C.I. MASTICS	Asphalt vapor-barrier weathercoats	M-3-A, B, C
	60-30/60	FIRE-RESISTIVE MASTICS	UL-listed non-asphaltic flexible weathercoats	M-3-A
	*60-30N/60N	FIRE-RESISTIVE MASTICS	Non-asphaltic flexible weathercoats with non-flammable solvent	M-3-A, C
	60-40	INSULFAS	Fire-resistive insulating mastic for ducts and vessels	M-3-B
	60-80	SAFETEE MASTIC	UL-listed asphalt "breather" weathercoat	M-3-A
	60-99	HiLASTIC MASTIC	Flexible asphalt weathercoat of HiLastic system	M-3-D
	90-07	H.I. MASTIC	Fibrated asphalt emulsion "breather" coating	M-3-A
adhesives	*81-42W	LAGFAS	Economical adhesive for lagging canvas on insulated piping	A-3-A
flashings	30-14	ASPHALT SEAM SEALER	Chemical and water-resistant flashing compound	F-3-A, C, E
	30-43	HEAT-RESISTANT SEALER	For flashings at temperatures to 400°F	F-3-E
	30-45	FOAMSEAL	Flexible sealer for dual-temperature insulations	F-3-C, E
	30-46	INSULATION SEALER	Flexible sealer for year-round use	F-3-B, C, D
	60-25	C.I. MASTIC	Asphalt sealer for vapor-barrier on pipe jackets	F-3-D
	*60-30N	FIRE-RESISTIVE MASTIC	Non-bleeding, non-flammable, elastic sealer	F-3-A
coatings	*30-36	SEALFAS	Light-colored fire-resistive, abrasion-resistant coating	C-3-A, C
		*LAGTONE	Fire-resistive coatings in white and colors	C-3-B
		*VITECT VINYL	Chemical-resistant coatings in colors	C-3-A, B, C
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The Bulletins listed above are designed to help you solve specific insulation-protection problems. For copies, simply note the numbers on this coupon and mail.

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Please send me the Bulletins for Process Industries which I have noted. I understand there is no obligation.

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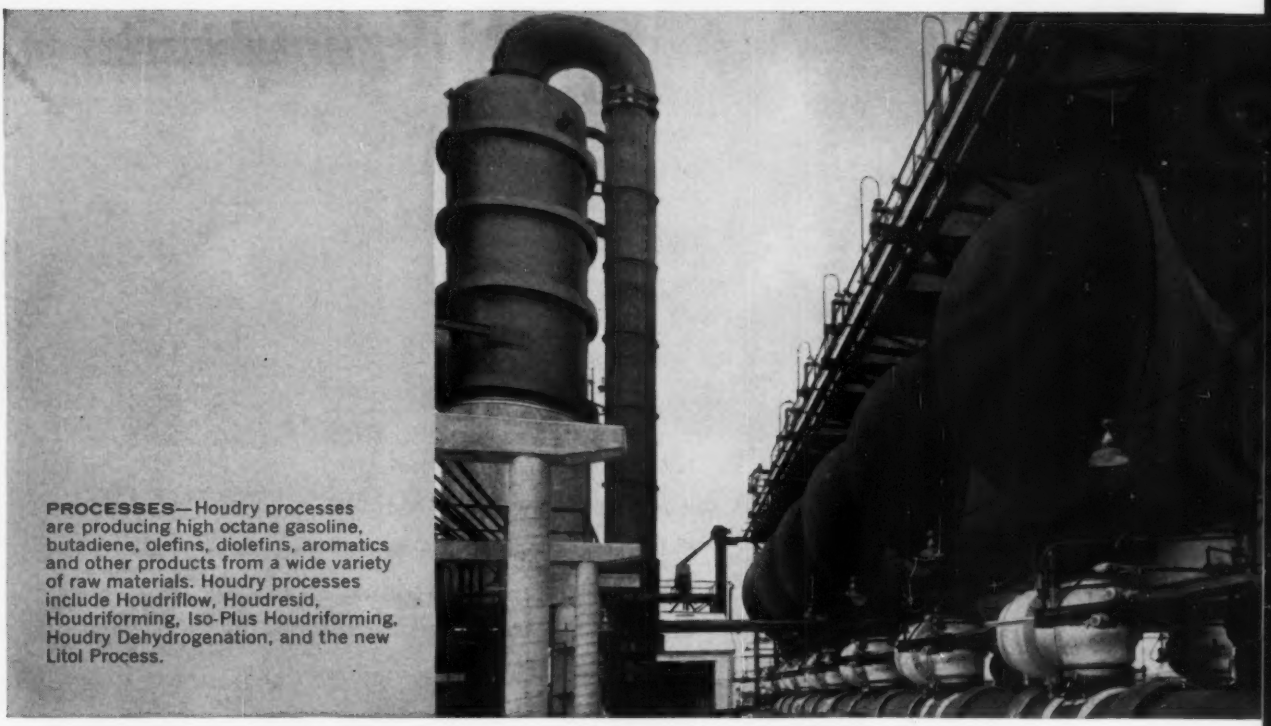
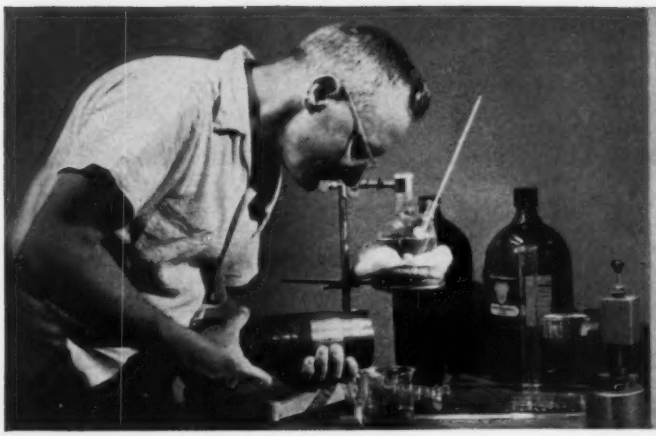
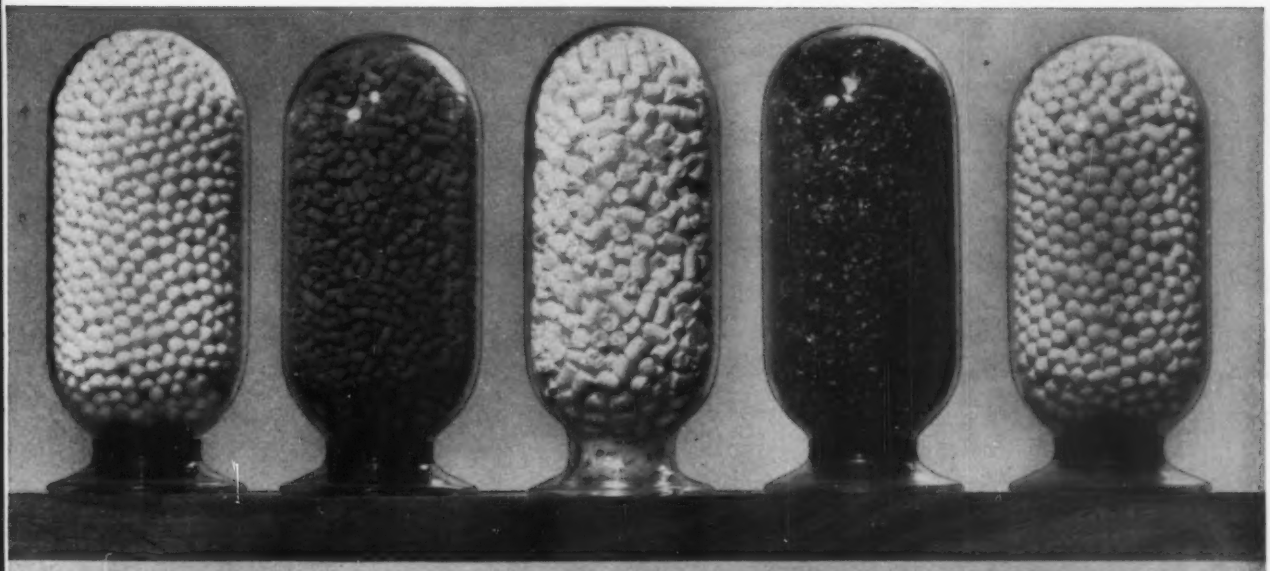


PROCESSES—Houdry processes are producing high octane gasoline, butadiene, olefins, diolefins, aromatics and other products from a wide variety of raw materials. Houdry processes include Houdriflow, Houdresid, Houdriforming, Iso-Plus Houdriforming, Houdry Dehydrogenation, and the new Litol Process.

WHEN THE QUESTION IS CATALYSIS...THE ANSWER IS



CHEMICALS—Developmental work at Houdry has resulted in a number of commercially promising chemicals. They can be generally described as nitrogen containing organic types. More complete descriptions of their properties, typical uses, and possibilities may be obtained on request.



CATALYSTS—Houdry manufactures and supplies a wide range of catalysts for petroleum, petro-chemical and chemical processes. Custom catalysts are also manufactured to order.

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Houdry processes . . . catalysts . . . chemicals . . . services . . . are based on more than 30 years of experience in catalysis. For processors, this extensive experience in different-but-related areas of catalytic processing means unique benefits.

For instance, the catalyst buyer finds—often to his advantage—he is dealing not only with a catalyst manufacturer, but a company fully able to evaluate his process and help him utilize the catalyst more fully than might be possible otherwise.

Likewise, the processor who needs plant-operating assistance finds not only this, but wide experience in engineering and process design, as well.

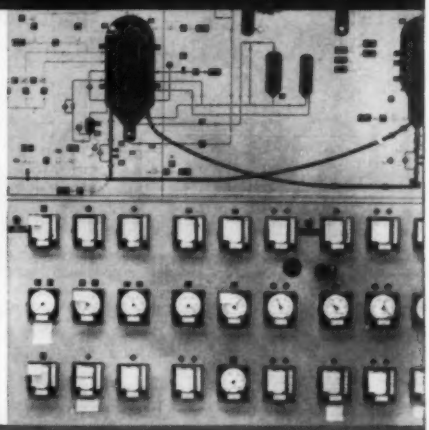
Houdry process designs are improved by knowledge of catalyst behavior. Services are perfected by experience in continuing research on both processes and catalysts, and so it goes.

Thus the *total* of Houdry's broad experience adds value to specific Houdry products and services.

Today, as ever, here is proof, that Houdry means Progress . . . through Catalysis.

SERVICES—The wealth of experience Houdry has gained in petroleum and chemical processing is available to industry through Houdry services. These include Economic Consultation, Engineering, Research, and Technical Assistance—covering the entire range of catalytic processing.

Bristol Metagraphic recorders and indicators occupy lower three rows on panel (shown in two photos above). Enlarged panel section is shown below, right.



"NERVE CENTER" AT BIG NEW TEXACO PLANT INCLUDES BRISTOL METAGRAPHICS

This model central control room is the nerve center for a vast petroleum processing complex. It's located in the new Puget Sound Works of Texaco Inc., at Anacortes, Washington.

A key feature of the control system is a battery of several hundred Bristol Metagraphic pneumatic recorders, indicators, and controllers (lower three instrument rows on panel). The new plant produces motor gasolines, jet fuels, liquified petroleum gases (LPG), diesel fuel, furnace oil, and heavy fuel oil. Crude oil capacity is 45,000 barrels per calendar day. O.7

BRISTOL ... for improved production through measurement and control
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

This is just one of hundreds of installations of Bristol Metagraphic instruments in use today in processing plants throughout the country. These compact instruments are ideal for graphic panel use, or where true "plug-in" versatility is necessary to insure maximum control system reliability and continuity of service. We'll be glad to send you the complete Metagraphic story. Write: The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

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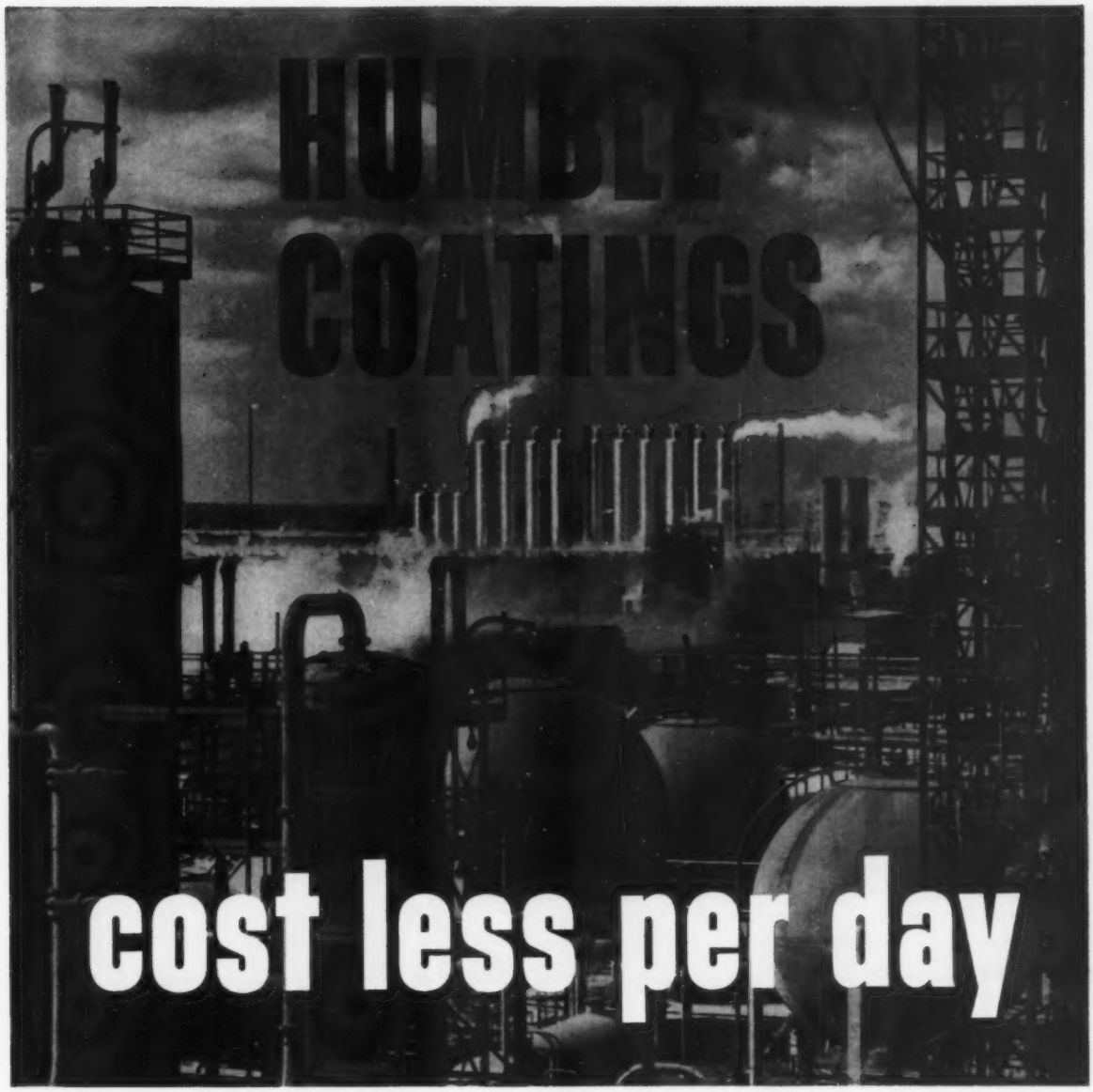

Humble paints and protective coatings last longer — extend the interval between your repaints by six months to a year. Fewer paint jobs mean savings on paint and labor. Cost per day is that much less.

But this is your big saving: Humble coatings give you better protection — they pay off in longer life for expensive equipment.

Developed to give maximum protection under the severe corrosive conditions in refineries and chemical plants, these continuously improved coatings have been profitably used by industry for over 25 years.

For more information on Humble's complete line of paints and protective coatings call your Humble salesman, or contact Humble Oil & Refining Company, Houston, Texas.

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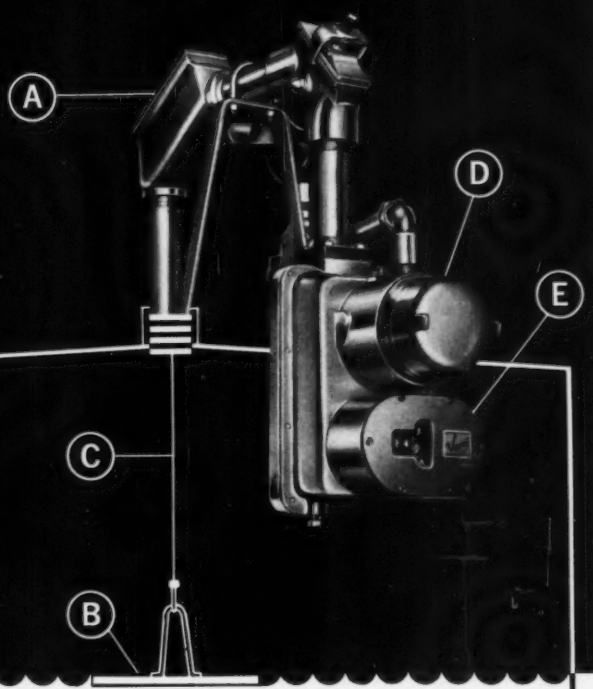
A POWER-DRIVEN LIQUID-LEVEL TANK GAUGE THAT COMBINES HIGH ACCURACY AND RELIABILITY WITH ECONOMY



The **DYNAMATIC** measuring device has a force measuring mechanism that consists of a torque tube, arm and contacts **(A)** and a displacer that can be any size, shape or material **(B)**. The displacer is suspended on the torque arm by a conventional perforated steel tape **(C)** and is driven in and out of the liquid by a reversible, two-phase servo motor **(D)**. Liquid level is indicated on a dial in the gauge head **(E)**.

The DYNAMATIC* 8400 Series is a power-driven tank gauge that operates continuously to keep a solid-plate displacer at the liquid level. It eliminates troublesome friction problems associated with floats, counterweights and spring balances, and provides a 1/16" tank gauging accuracy over a working range of 60 feet.

Reliability is insured by the simple force-balance system and the use of a solid-plate displacer that cannot leak, be ruptured by pressure, or 'hung-up' to cause tape entanglement. The system is unaffected by change of tank product, and needs no compensation for specific gravity changes. It performs more reliably than expensive, sonic systems or electronic probes and costs little more than conventional float systems.

Only the
DYNAMATIC
Power Gauge Offers All These Advantages:

- 1/64 inch accuracy at depths from 0 to 60 feet.
- A continuously operating servo motor that keeps displacer constantly at surface of liquid level . . . 1/64 inch sensitivity to liquid-level changes.
- Automatic operation check through continuous power gauging action . . . direct reading at tank or remotely by electronic adaptation.
- Automatic compensation for variations in tape weight.
- All electrical equipment in explosion-proof enclosures.

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For more information on the new DYNAMATIC 8400 Series, write for VAREC Bulletin CP3705, Dept. PR-1152-1.

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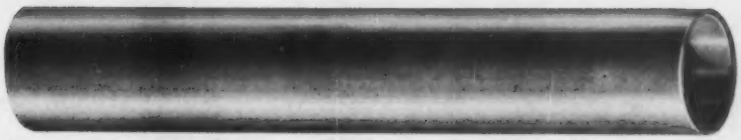
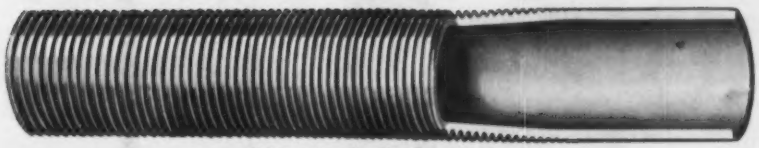
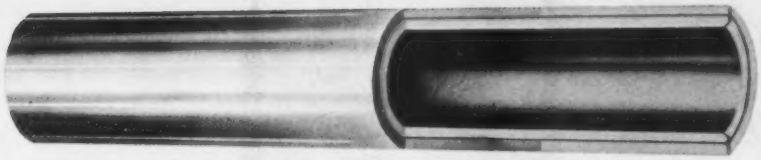


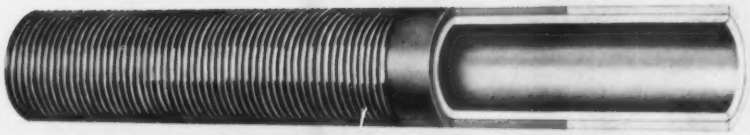
Wolverine Prime Surface Tube



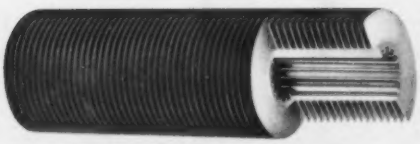
Wolverine Trufin Type S/T



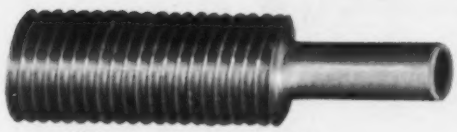
Wolverine Prime Surface Tube (Duplex)



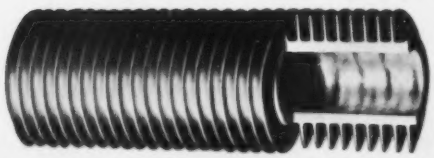
Wolverine Trufin Type S/T (Duplex)



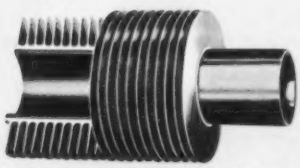
Wolverine Trufin Type I/L



Wolverine Trufin Type H/R

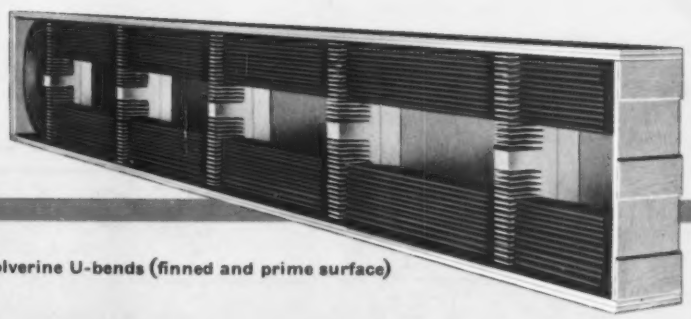


Wolverine Trufin Type H/A



Wolverine Trufin Type L/C (Bimetal)

Here's why you should buy condenser tube from WOLVERINE TUBE



Wolverine U-bends (finned and prime surface)

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WHEN you want inside information about a product, one of the finest places to get it . . . is right from the people who make the product. They know all about it because their livelihood . . . their very future . . . is tied to the way their product meets *your* requirements and wins *your* acceptance. Recently, we asked Wolverine employees why they thought that equipment builders and processing companies should buy Wolverine condenser tube. We believe their reasons offer you some very significant buying considerations:

"BECAUSE we perform an expansion test on a sample taken from the end of *every* length of condenser tube."

"BECAUSE we use the most modern control techniques available to assure top quality."

"BECAUSE we manufacture a complete line of nonferrous condenser tube making it possible for our customers to buy finned or prime surface condenser tube in almost any popular alloy."

"BECAUSE we were the first to develop integrally finned tube—since we have more than 25 years of experience and know-how our product superiority and tubular competence is especially high."

"BECAUSE we can supply seamless condenser tube in special metals such as zirconium, titanium, etc."

"BECAUSE we have a continuous program for the development of our products through our separate Research and Development facilities."

"BECAUSE we are quality conscious."

"BECAUSE we understand good packaging practices and will unitize or palletize tubing requirements to meet the needs of our customers."

"BECAUSE we want the good will of our customers as well as their business."

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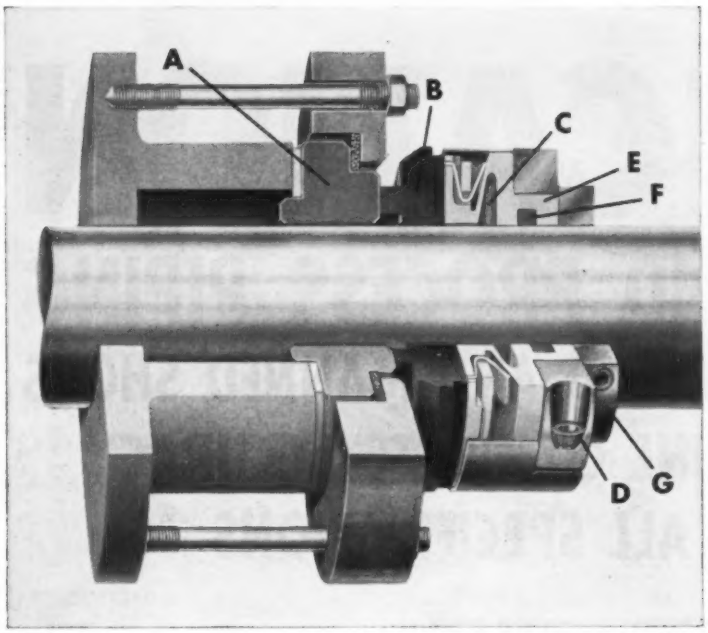

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Garlock CHEMISEAL* Mechanical Seals have, through years of application, proved their ability to seal effectively against all chemicals . . . from the "easier" Methanol, Acetic and Propionic Acids to the more reactive Hydroxyacetic, Sulfuric, Adipic Acids and Hydrocarbon Slurry.

High-quality construction. The bellows unit of CHEMISEAL Mechanical Seals is, in all cases, made of chemically-inert Teflon†. Various materials are used for the sealing faces dependent upon the medium and service requirements. Referring to the illustration at left, the seal comprises a stationary face "A" secured to the stuffing box and a rotary face "B" which rotates with the balance of the seal mechanism and is secured to the shaft. Between these precision lapped faces a leak proof seal is accomplished by the spring loaded Teflon bellows section "C." Clamp "D" secures area "E" to the shaft with the help of the Hypalon or Teflon O-Ring "F," forming a drop-tight seal. Back-up collar "G" is an added precaution to prevent the seal from working out on the shaft.

There are other benefits, too, that CHEMISEAL Mechanical Seals can add to your particular application. Consider the fact that they offer a life expectancy many times that of other seals . . . don't score the shaft during operation . . . are easy to handle and install.

Solve your difficult sealing problems. Apply Garlock CHEMISEAL Mechanical Seals against all media—including solids in suspension—in pressures to 100 psi at 75°C, or 75 psi at 100°C. Standard sizes to fit all pump shafts from 7/8" to 2 1/8"; special sizes also available. Discuss complete details with your local Garlock representative, or write for Catalog AD-164. Garlock Inc., Palmyra, New York.

GARLOCK

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

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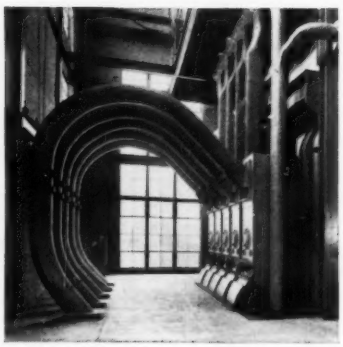
ONLY SHOP FABRICATION OF POWER AND PROCESS PIPING IN PFI MEMBER EQUIPPED AND MANNED SHOPS CAN PRE-DETERMINE COMPLETE ACCURACY IN MEETING ALL SPECIFICATIONS



Advanced design, processing improvements and progressive engineering all call for more exacting piping specifications.

In turn, this requires the best possible utilization of modern fabrication techniques.

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Simply circle the Standards you can use and mail to PFI at the address above.

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4 Shop Hydrostatic Testing
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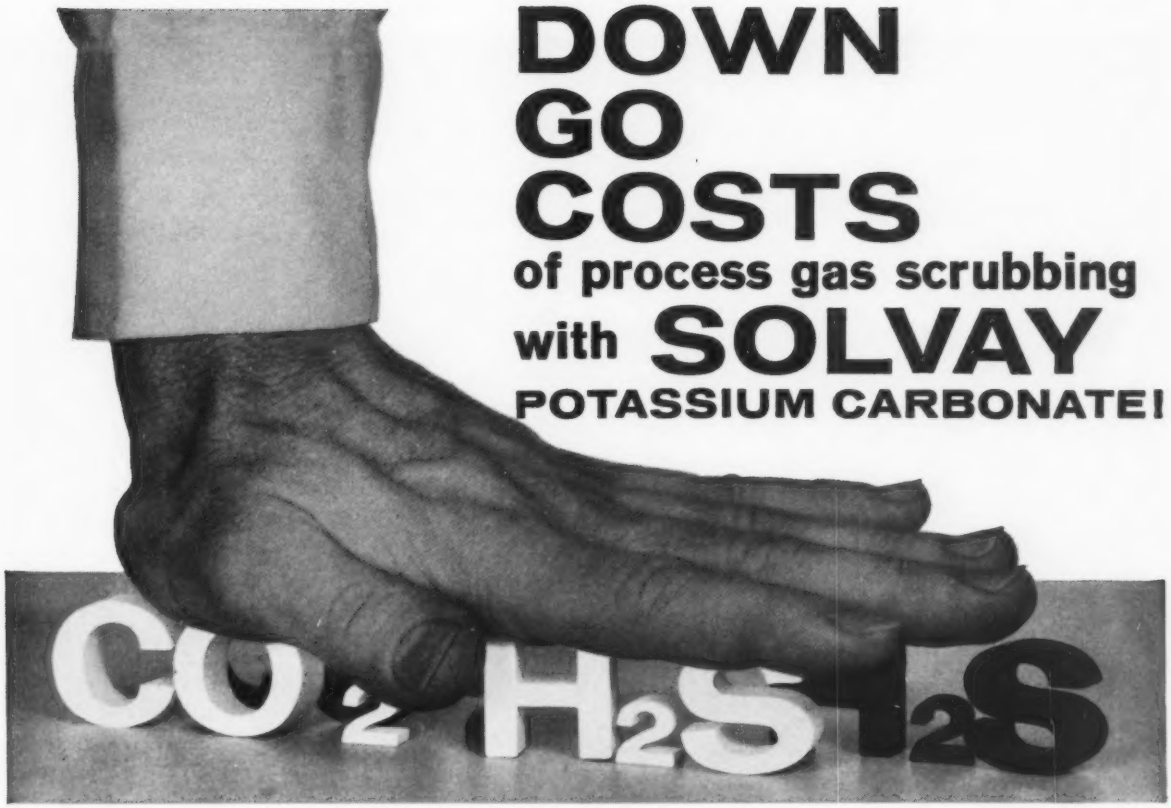
6 Built-up Weld, Metal Bosses
7 Welded Nozzles — Spacing
8 Preheat - Postheat Welding, Low Chrome — Moly Pipe
9 Arc-Welding Dissimilar Ferritic Steels
10 Stress Relieving Practices
11 Affixing Permanent Symbols to Piping
12 Preheat - Postheat Welding, Medium Low Chrome — Moly Pipe
13 Classification, Shop Testing, Inspection, Cleaning



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Save on utilities and fuel . . . purify process gases using the Hot Carbonate Process with Solvay® Potassium Carbonate. The hot circulating carbonate solution does away with costly heat exchangers and reduces steam requirements.

Wherever conditions of fairly high concentration and partial pressure exist, this is the most economical way to take out carbon dioxide from process gases. Applications range from ammonia synthesis to petrochemicals.

In natural gas treating, it is used to remove *both* carbon dioxide and hydrogen sulfide. Compare the potassium carbonate method's cost and economy with other gas-removal systems.

Mail the coupon below!

Sodium Nitrite • Caustic Soda • Calcium Chloride • Chlorine • Chloroform Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash Ammonium Chloride • Methyl Chloride • Ammonium Bicarbonate • Vinyl Chloride Methylene Chloride • Cleaning Compounds • Hydrogen Peroxide • Aluminum Chloride • Mutual® Chromium Chemicals • Snowflake® Crystals • Monochlorobenzene • Ortho-dichlorobenzene • Para-dichlorobenzene • Carbon Tetrachloride

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast. Send export inquiries to Allied Chemical International, 40 Rector St., N. Y. 6.

Mail to Solvay, without obligation. Check articles desired:

- ☐ "For bulk removal of acid gases . . . Costs Favor Hot Carbonate Process" —Chemical Engineering.
- ☐ "CO_2 Removal from Natural Gas"—Oil and Gas Journal.
- ☐ "Economics of Acid-Gas Removal"—Oil and Gas Journal.
- ☐ "Improved Process for CO_2 Absorption"—Chemical Engineering Progress.
- ☐ "Hot Potash Process for Gas Purification"—Oil and Gas Journal.
- ☐ "Which CO_2 Removal Scheme Is Best?"—Petroleum Refiner.
- ☐ "New Potassium Carbonate Process"—Petroleum Refiner.
- ☐ "Solvay Potassium Carbonate" fact book.

Name_____

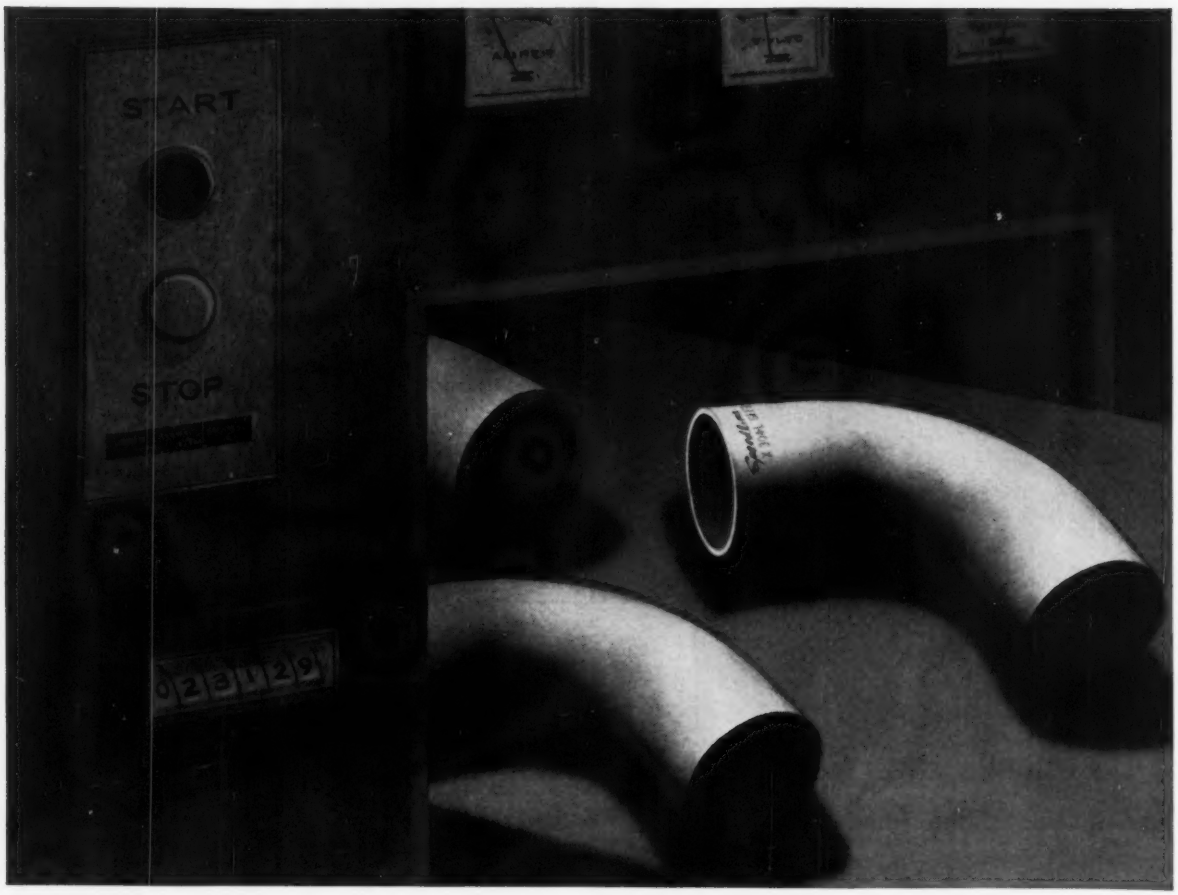
Company_____

Address_____

City_____ Zone____ State_____ 68-90

For more data on advertised products, use Readers' Service Cards, last page.

THERE IS A DIFFERENCE IN PIPE FITTINGS



Speedline® FITTINGS ARE MADE TO MEET CRITICAL STANDARDS

Now you can comply with the severest codes and save up to 50% on *critical* stainless steel process lines when you specify SPEEDLINE Fittings and economical light wall Schedule 5 or 10 pipe.

The new issue of Code for Pressure Piping ASA B31.3-1959, for example, allows a *design pressure* of 611 psi for 2″ ips Schedule 5, Type 304L process pipe at 100°F. Under the same conditions, allowable design pressure for 1½″ ips pipe would be 768 psi; for 1″ ips, 1122 psi.

Since SPEEDLINE Fittings have been specially designed for use with light wall pipe, they can result in substantial installation economies whether you plan to butt-weld, flange or socket-join your lines. Yet *long tangent* SPEEDLINE Fittings cost no more than other fittings which are suitable for "non-critical" service only.

Let a SPEEDLINE Distributor show you why there *is* a difference with SPEEDLINE Fittings... and what that difference can mean at your plant. Complete Catalog on request.

For Distributor Listings see pages 1513 to 1516 Chemical Engineering Catalog. 1005

Speedline®

CORROSION-RESISTANT FITTINGS

STAINLESS STEEL • ALUMINUM • SPECIAL ALLOYS

A PRODUCT OF HORACE T. POTTS COMPANY • 566 E. ERIE AVENUE • PHILADELPHIA 34, PENNSYLVANIA

Use the Oil Bank of the Southwest to help you increase your returns from oil and gas activities. Every member of our Oil and Gas Department is experienced in both oil and banking. A large number of our directors and advisory committee are oilmen too! We understand the problems of the explorer, producer, researcher, refiner, transporter, wholesaler and retailer. It will be a pleasure to serve you.

Photo: Petroleum Engineers Frank E. McGonagill, Jr., (right), Vice President and Herbert F. Poyner, Jr., Assistant Vice President, inspect a gasoline plant, one of the major oil activities financed by Bank of the Southwest.

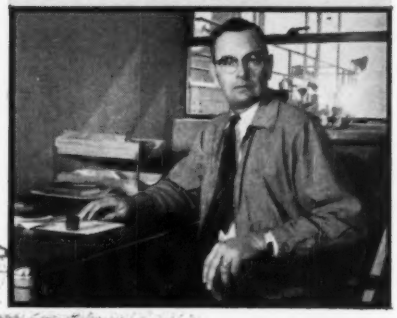
MEMBER F.D.I.C.

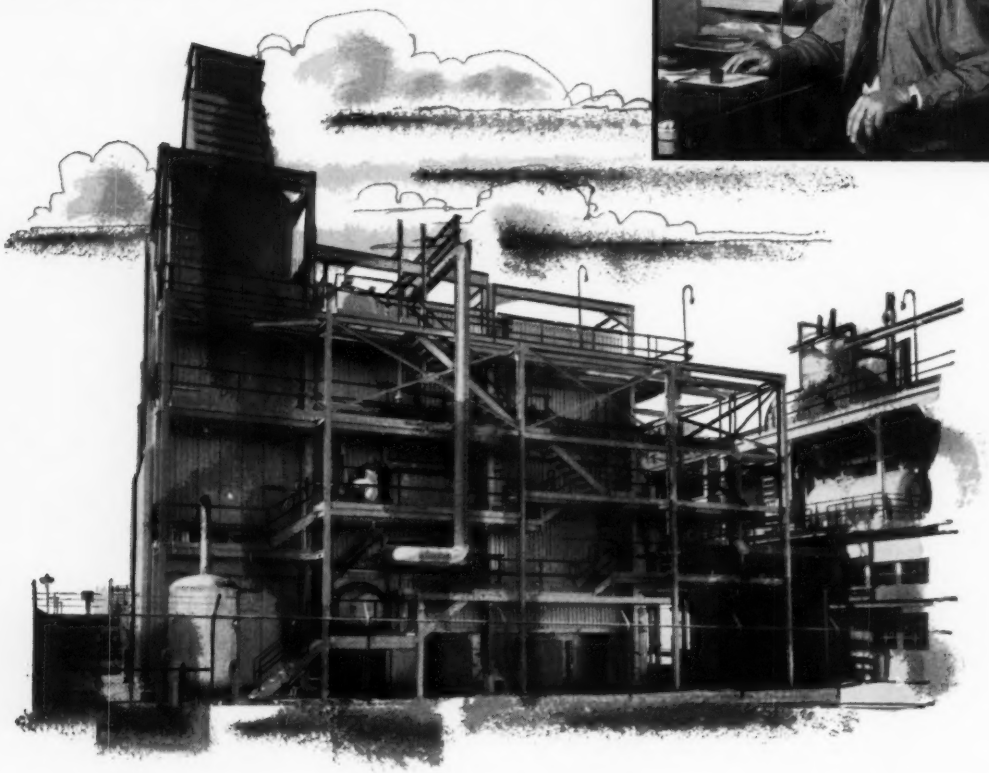
Bank of the Southwest
NATIONAL ASSOCIATION, HOUSTON

NEW WICKES STEAM GENERATOR

insures maximum efficiency and dependability for BRYAN, TEXAS, MUNICIPAL POWER PLANT

Calvin W. Beard, Superintendent of the Electric Utilities of Bryan, Texas, Municipal System: "As in every other power plant, our steam generator must give completely dependable performance day in and day out".





This Wickes Type RB 2 drum boiler is designed to produce 220,000 lbs. of steam per hour at 875 psig and 900° total steam temperature for the city of Bryan, Texas. The unit performs not only with remarkable dependability, but with Wickes' usual efficiency and economy. Wickes Boiler Co. builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods. See your nearest Wickes representative for full information on a Wickes steam generator designed to suit your needs.

WICKES

RECOGNIZED QUALITY SINCE 1854

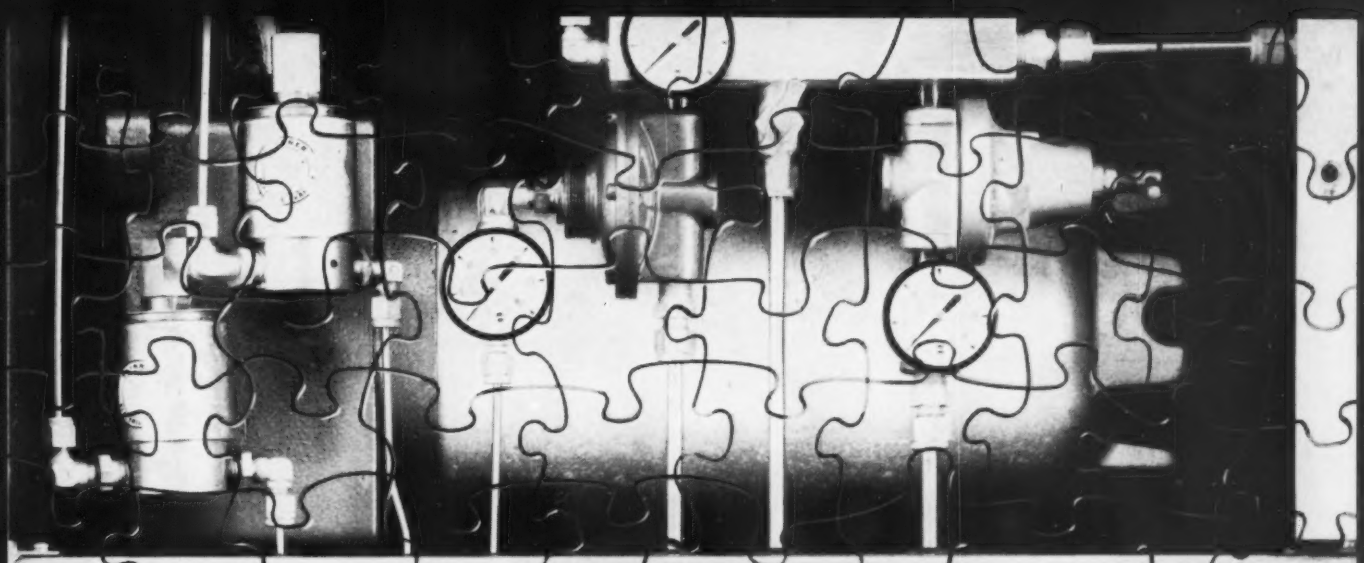
Sales Offices: Atlanta • Boston • Charlotte, N.C. • Chicago • Cleveland Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N.Y. • Saginaw • San Francisco • Seattle, Wash. Springfield, Ill. • Tulsa

Bulletin 55-1 gives details of a wide variety of designs and sizes of Wickes field-erected and shop-assembled steam generators. Write for your free copy.

174

WICKES BOILER CO., SAGINAW 18, MICHIGAN, DIVISION OF THE WICKES CORPORATION

For more data on advertised products, use Readers' Service Cards, last page.



Puzzled by your gas chromatograph problem?

Beckman offers the correct solution. The new Model 320C Industrial Gas Chromatograph now affords management precise control of operations, and more predictable profits. Modular design of a basic production instrument permits extreme flexibility of column configuration and valve arrangement to meet widely varying process needs. No other instrument can handle analyses faster with equal simplicity of operation and maintenance. ⌘ The versatile new Model 320C is adaptable to virtually any monitoring and control application. A typical few are: ammonia, urea and formaldehyde synthesis... chlorine, ethylene, butadiene and synthetic rubber production...butane isomerization...catalytic cracking and reforming...alkylation and distillation processes. ⌘ Whatever your specific process need, a Beckman Sales Engineer is ready to discuss it and recommend the most effective application. Or for literature and general application information write for Data File 25-9-07.

Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
Fullerton, California

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

CORROSION meets its match in Alcoa aluminum conduit

Here's an electrical rigid conduit that you can install and forget.

Alcoa aluminum conduit solves most corrosion problems in and around chemical plants.

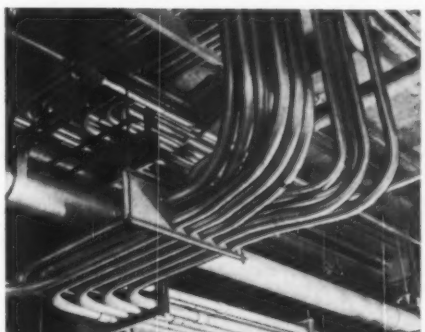
Aluminum protects itself Unlike other conduits, which require some kind of coating, aluminum forms its own protective film. This film forms naturally in the atmosphere and in the presence of oxidizing agents. Damaged spots are self-repairing—almost instantly! The natural oxide coating on aluminum takes the place of factory coatings on conventional conduits and only under unusual conditions is any other protection required.

Other advantages Corrosion resistance is just one good reason for selecting aluminum conduit. Its light weight (about ⅓ as much as steel) makes it easier to handle and install. Alcoa aluminum conduit is also nonmagnetic and nonsparking.

How about cost? Consider initial cost, savings in installation and maintenance, and service life. You'll see that Alcoa aluminum electrical rigid conduit stacks up as a sound investment.

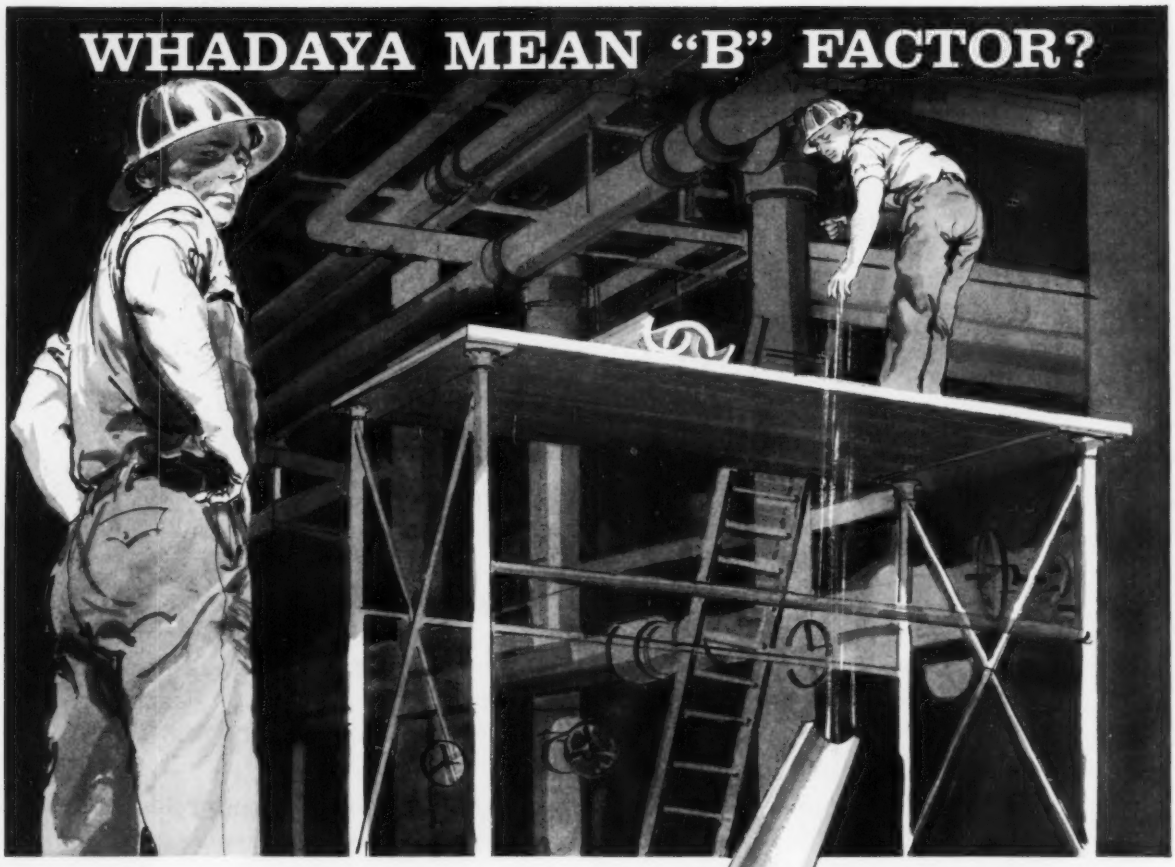
More information For specifications, or answers to specific questions about the use of aluminum conduit in corrosive environments, contact one of our nearby representatives. Or write to Rome Cable Division of Alcoa, Dept. 19-90, Rome, New York.

ROME CABLE
DIVISION OF **ALCOA**



NO CORROSION despite moisture, chemicals and vapors in the basement of this sewage disposal plant in Cleveland. Installed in 1932, this Alcoa conduit still looks almost like new.

WHADAYA MEAN "B" FACTOR?



Use Unibestos, the rugged insulation

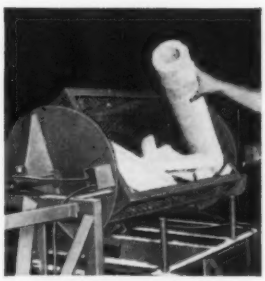
"B" is for Breakage . . . one of the most important cost factors on any insulation job. When you load for shipment, unload for warehouse, reload for job site, then unload and spot for installation, it takes a *rugged* insulation to get there with *no breakage.* And that's just what Unibestos will do for you. And how "B" factor saves cleanup time, too. No wonder 15% to 20% savings is not unusual.

That's also one of the reasons why Unibestos is worth more. Yet it continues to sell at competitive prices.

Hit it, drop it, ship it in ordinary cardboard cartons without packing and you still come up with tough, efficient insulation sections. Unibestos eliminates breakage and shrinkage; defies thermal shock, fumes, acids and moisture; cuts application time and costs; and guarantees real insulating efficiency.

Available in a full range of standard pipe sizes and in block form. Single thicknesses up to five inches. Specials to 44" O.D. in half sections.

Write today, on your letterhead, for Bulletin No. 65610.



Tumbling apparatus illustrated above was used to simulate jars incurred in LCL shipments. After 29.2 minutes (204 revolutions) Magnesia insulation is completely broken down. Unibestos remains O.K. for installation because of its exclusive long-fibered *Amosite* asbestos.

UNIBESTOS

worth more, yet sold at competitive prices

UNARCO®

UNARCO PRODUCTS

• UNIBESTOS, Amosite Asbestos Pipe Covering and Block • Calcium Silicate Pipe Covering and Block • 85% Magnesia Pipe Covering and Block • Mineral Fiber Block • Wrap-On Insulation • Lace-On Insulation • Turbine Blankets • Insulating and Finishing Cements • Asbestos Textiles • Packing and Gasketing.

UNION ASBESTOS AND RUBBER COMPANY • FIBROUS PRODUCTS DIVISION

DEPT. 264, Bloomington, Illinois

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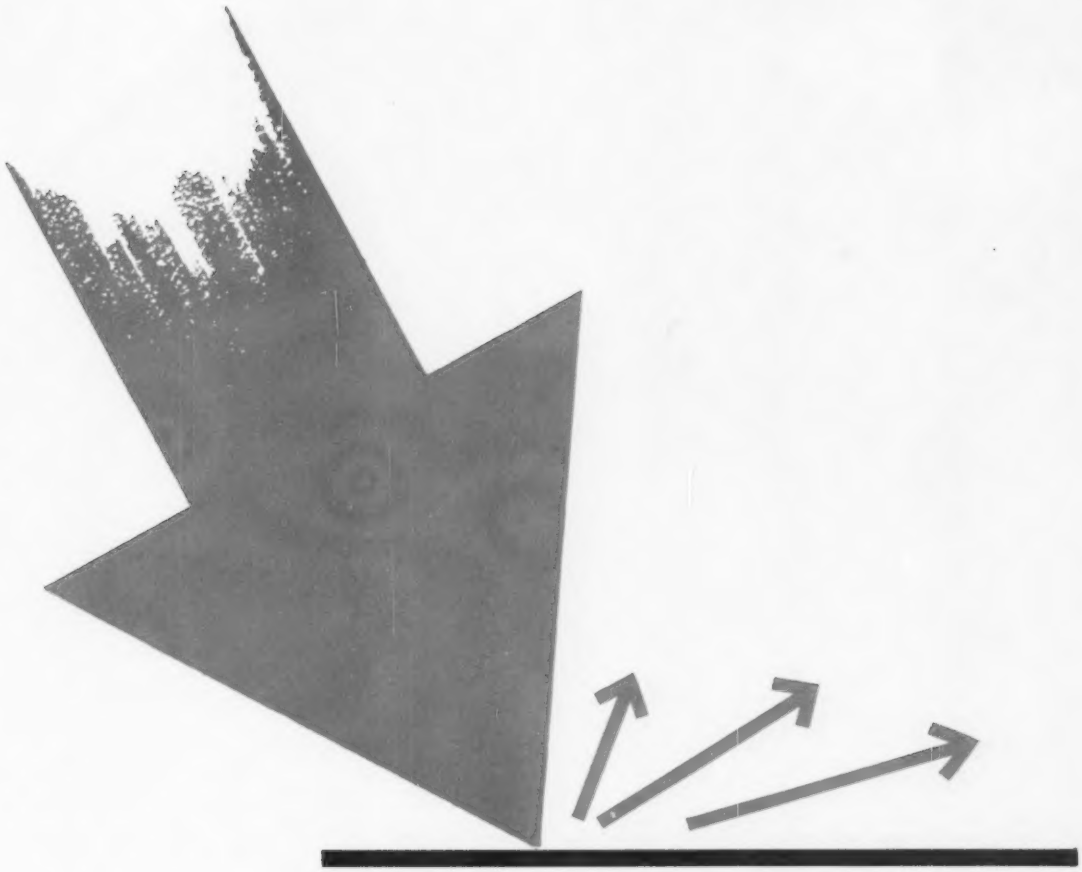
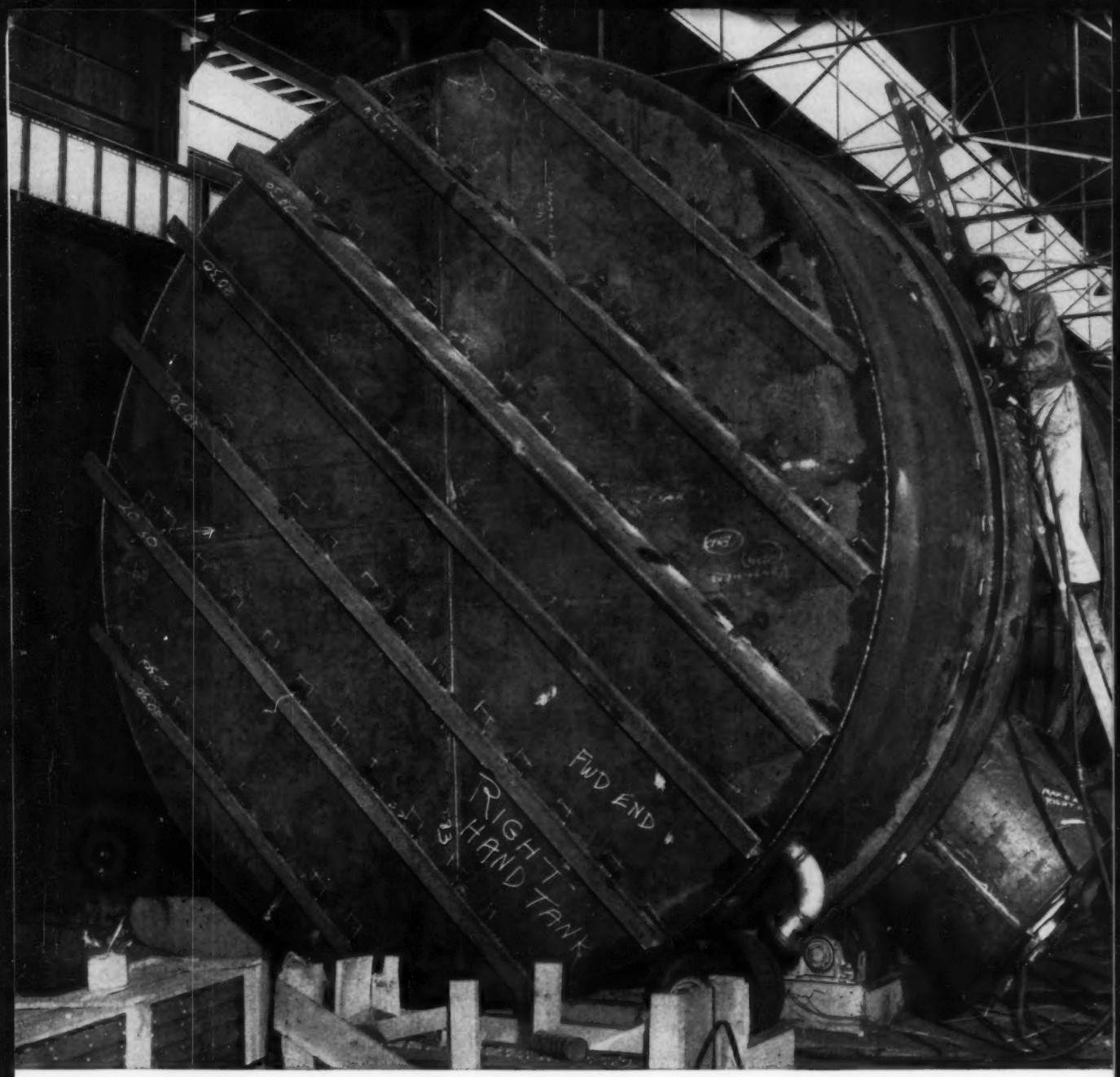


Metallurgical Phenomena... and the metals to cope with them.

These are the stock-in-trade of the Lukens Application Engineer—whether the problem be one of abrasive impact (symbolized above) or corrosion or pressure or structural stress or high and low temperature. Investigation of the best steels for "problem" applications has been carried on for years by the Lukens Application Research team. We would welcome the opportunity to contribute the results of this research to your own design knowledge. Please contact us in your early design stages. Call collect: Joe Proctor, Manager of Application Engineering, Extension 422, Lukens Steel Company, Coatesville, Pennsylvania.

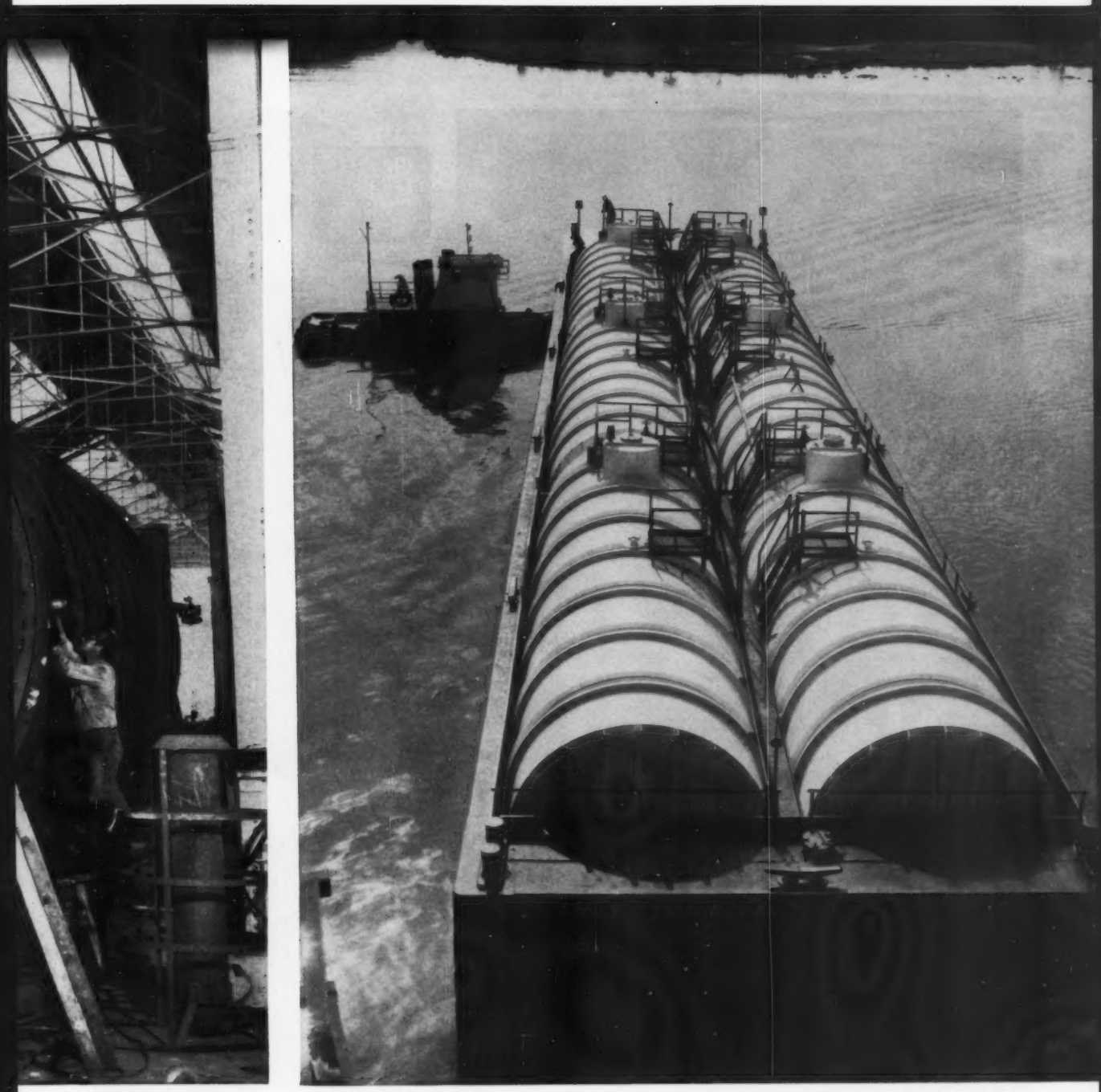
HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB

For more data on advertised products, use Readers' Service Cards, last page.



Tanks as big as a barge can carry

These new tanks have unobstructed interiors to carry maximum cargo with least danger of contamination—the essential requirements of an order for two independent tank barges from Union Carbide Chemicals Company. One barge is designed to carry Grade A and lower liquids having a Reid Vapor Pressure not exceeding 25 psi. The other barge will carry similar cargoes having a Reid Vapor Pressure not exceeding 40 psi. ☐ American Bridge designed and constructed the tanks and barges at its modern Plate Shop in Orange, Texas. The results: two Jumbo Hopper Barges 195′ x 35′ containing six tanks 52′ long x 14′-6″ O.D. and weighing 22 tons with a total



capacity of 383,000 gals. per barge. The reinforcing members for the tanks were placed on the tank exteriors leaving unobstructed nickel-plated interiors. ☐ Whatever your plate needs, we have the staff and facilities to take care of them, and our strategic location permits shipment by train, truck or barge. Write for our booklet completely describing plate fabricating and construction services.

USS is a registered trademark

General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York

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USS

WARNER LEWIS COMPANY
BOX 3096 • TULSA, OKLAHOMA

SILENT SERVANT OF SAFETY

jets DEMAND CLEAN FUEL

Clean jet fuel is essential to safe jet aircraft operation. Today, all aviation fuels may be provided the ultimate protection against fuel contamination. The new Warner Lewis 2-stage separator/filter eliminates jet fuel contaminants — free water and dirt — and delivers the cleanest fuel ever demanded by commercial or military aircraft.

A Silent Servant of Safety, this equipment is installed on fueling facilities serving most of the world's major airports. It is approved and in production for the U. S. Air Force under recent contracts. For further information, write Aviation Products division, Warner Lewis Company.

DIVISION OF FRAM CORPORATION In Canada: FRAM Canada Ltd., Stratford, Ontario

POWELL LUBRICATED PLUG VALVES

performance that makes a world of difference

For over a century, Powell has supplied vital valves to the all-important oil industry. Today, the complete line includes valves of all types. Powell has the greatest variety of sizes, designs, pressures and metals. There is one to cover every valve need in oil refineries, petrochemical installations, and storage facilities everywhere.

Powell engineers and metallurgists will gladly make a special analysis of your requirements and submit recommendations to fill all your valve needs. Write directly to us . . . or consult your local Powell distributor.

Powell . . . world's largest family of valves

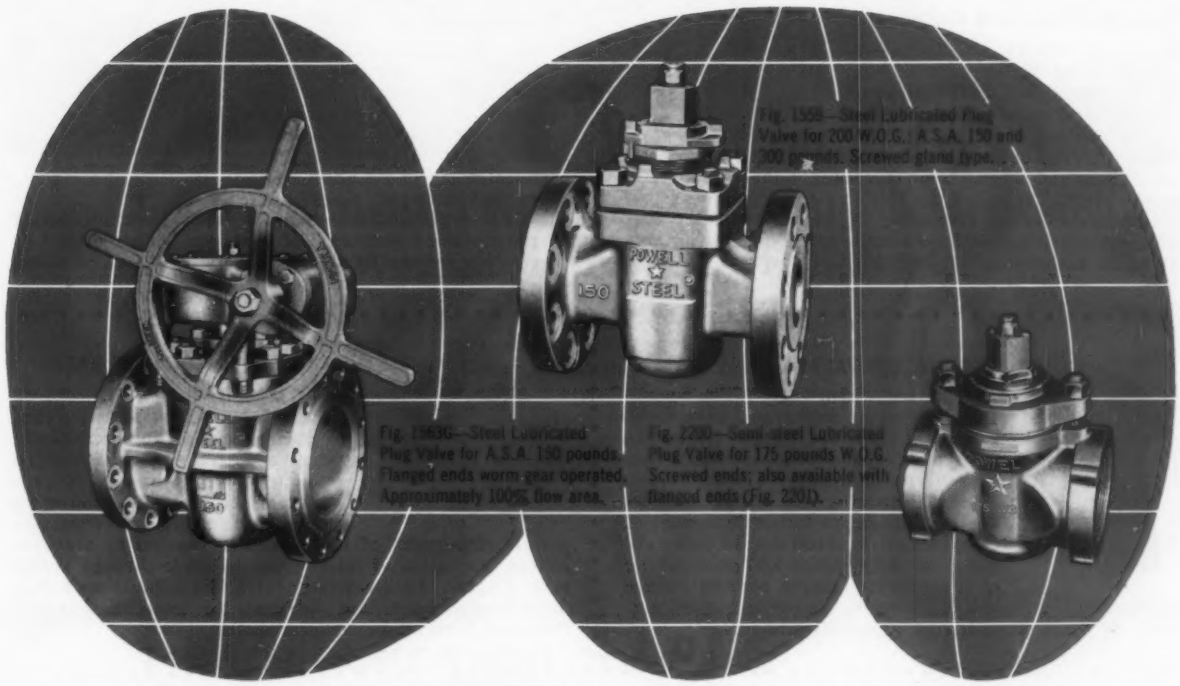


Fig. 1559—Steel Lubricated Plug Valve for 200 W.O.G. / A.S.A. 150 and 300 pounds. Screwed gland type.

Fig. 1563G—Steel Lubricated Plug Valve for A.S.A. 150 pounds. Flanged ends worm gear operated. Approximately 100% flow area.

Fig. 2200—Semi-steel Lubricated Plug Valve for 175 pounds W.O.G. Screwed ends; also available with flanged ends (Fig. 2201).

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

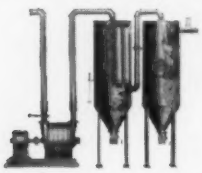
U.S. HOFFMAN MACHINERY CORP.

AIR APPLIANCE DIVISION — 103 Fourth Ave., New York 3, N. Y.

Designers and manufacturers of multistage centrifugal air and gas blowers/exhausters—portable and stationary industrial vacuum cleaning systems — pneumatic conveying equipment — dust collectors — Smooth-Flow tubing and fittings — continuous metal, rubber and plastic strip/sheet dryers — steam and gas operated air heaters — valves and accessories.

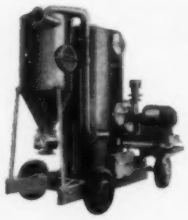
MULTISTAGE CENTRIFUGAL BLOWERS & EXHAUSTERS

Rugged cast iron Hoffman blowers deliver clean dry air or gas in continuous duty applications such as combustion, agitation, drying, vacuum cleaning, sewage and waste treatment, pneumatic conveying, air squeegee, ore flotation, circulation of liquids, asphalt blowing, etc. Pressures to 10 psig, vacuums to 12" hg, and volumes to 20,000 cfm. Outboard mounted bearings. One piece cast aluminum impellers. Dynamically balanced rotors. No internal wearing parts. Vibration free operation. Constant pressure or vacuum throughout capacity range. Suitable for direct drive by motor, turbine or engine. Common steel baseplate.



STATIONARY VACUUM CLEANING SYSTEMS

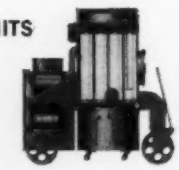
Permanently installed stationary vacuum systems ranging from 3 hp to 100 hp permit cleaning operations throughout the plant with collection at a central location. These systems will help prevent product contamination, insure better housekeeping, salvage valuable materials, eliminate manual handling and disposal. Heavy duty dust separators receive material and large filter cloth areas insure thorough separation. Suction hoses are inserted into strategically located inlet valves in piping system.



PNEUMATIC CONVEYING EQUIPMENT

Hoffco-Veyor pneumatic systems keep dry, powdery and granular materials on the flow. Permanent installations transfer a variety of materials including chemical powders, starch, plastic pellets, pharmaceuticals, etc., from one point to another in the production process. Rugged portable Hoffco-Veyors such as this trailer mounted unit, can be used to handle catalyst, clay, sand, etc., in refineries, brick plants and chemical installations.

PORTABLE VACUUM CLEANING UNITS



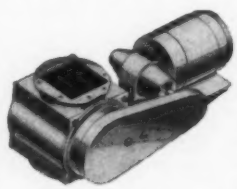
Maximum efficiency in industrial housekeeping can be achieved with Hoffman heavy duty portable vacuum cleaners which range from 1½ hp through 15 hp. Mobility and flexibility enables the operator to do an efficient and thorough job of vacuum cleaning anywhere in the plant. Typical of the Hoffman portable units is the 7½ hp Hoffco-Vac 75 developing 7.8" hg suction and capable of operating two hose lines simultaneously. Filtering area 48 sq. ft. Removable dust bucket with capacity of 7.5 cu. ft.

MATERIAL INTAKE VALVE

Unique feeding valves permit the introduction of dry free flowing materials into vacuum conveying systems. Design incorporates offset air and material entry ports making it possible to regulate material flow and yet allow air to enter the line for purging. Separate air inlet protects connected equipment from full suction of the system. Constructed of cast iron, stainless steel or bronze. Valves can be modified for air cylinder operation.

PERISTALTIC VALVE

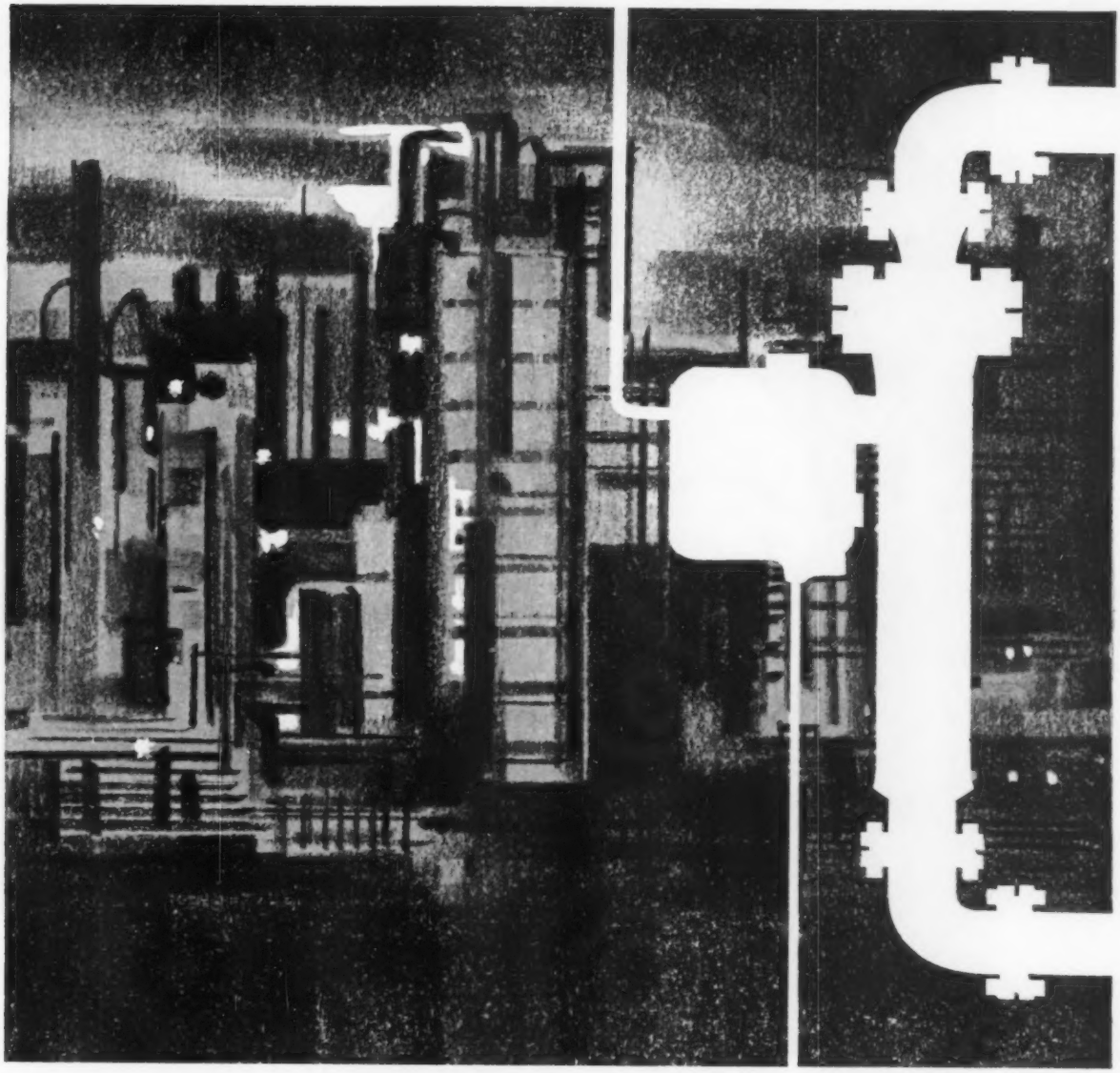
Rubber diaphragm valve utilizes peristaltic action to discharge materials in controlled quantities. Designed to handle the type of product which can not be successfully passed through a rotary feeder, Alternate opening and closing of sheet rubber diaphragms facilitate passage of coarse abrasives or odd shaped materials. Elliptical body section and sandwiching of diaphragms insures positive closure against high differential pressures. Fail-safe feature provided in event of rupture of either diaphragm.



ROTARY DISCHARGE VALVE

These chain-driven air-locks of cast semi-steel construction discharge materials from pneumatic systems. Valves have torque limiting drive sprockets to protect against jamming and overloading. Equalizing connections permit attachment of bleed lines to vacuum or pressure source. Inspection of interior can be made through access port without disassembling valve. Fabricated and cast multi-bladed rotors are designed for interchangeability. Standard horizontal shaft gear motors.

Write for illustrated catalogues. Our application engineers are available for a survey of your production and maintenance problems without obligation.



Fisher Level-Trols—universally accepted in the power and process industries

High in sensitivity and accuracy! For full float range operation the Fisher Level-Trol is factory calibrated or zero adjusted to produce an accurate 3 to 15 psi or 6 to 30 psi signal output. Designed, engineered and universally accepted for most liquid level control, liquid level indication and interface control problems. Has simple liquid level adjustment indicating dial—combined pneumatic proportional band and specific gravity adjustment. Heavy-duty built—easy to operate—simple to service. Available with cage units for external mounting or internal top or side flange mounting with float sizes from 14" to 120".

Write for Bulletin F4A for full details.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

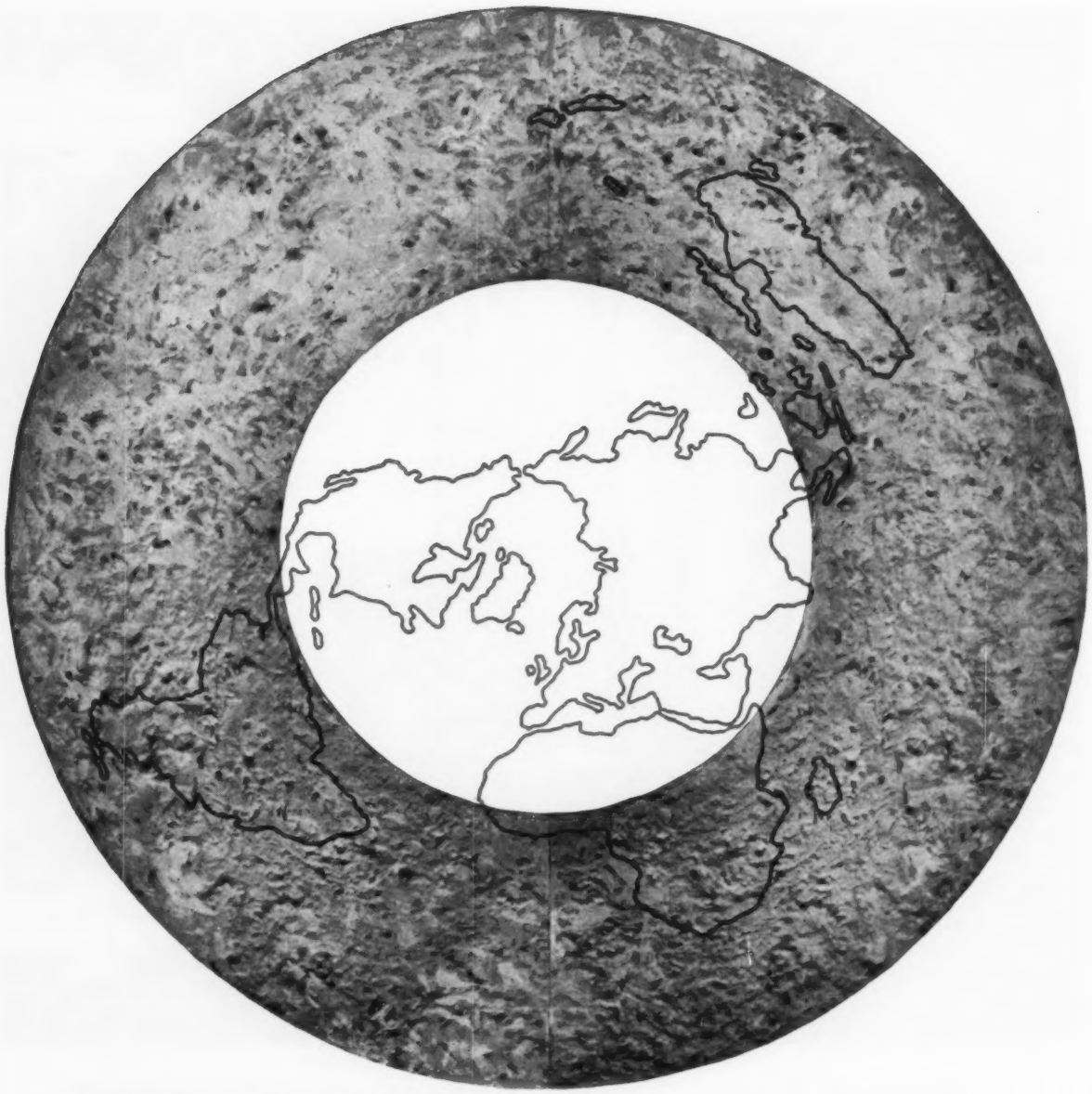
FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

FISHER® Controls

SINCE 1880

For more data on advertised products, use Readers' Service Cards, last page.



made the world over

—and to the same specification

Caposite amosite asbestos is manufactured under supervision to the same uniform specification in all these countries.

Great Britain	by The Cape Asbestos Company Ltd
Canada	by Caposite Insulations Ltd
South Africa	by Cape Asbestos Insulations (Pty) Ltd
Australia	by James Hardie & Company Ltd
France (as 'Isolamiante')	by Isolamiante SA
Italy	by Capamianto SpA
Holland	by J. de Boer & Company
Spain	by Messrs. Eduardo Rosa
Argentina	by Montisol Argentina. SRL
Japan	by Nippon Asbestos Company

Amosite asbestos insulation is also manufactured in U.S.A. under the name of 'Unibestos' by Union Asbestos Rubber Company.

CAPOSITE regd.

AMOSITE ASBESTOS INSULATION

THE **Cape Asbestos** COMPANY LTD 114 & 116 Park St. London W1. Grosvenor 6022

Enquiries to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario. North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois. Capamianto SpA via Sant' Antonino 57, Turin, Italy.

TA.3612

For cooling water systems, the latest word is ENDCOR®

ENDCOR – new from Dearborn's research laboratories, gives better corrosion control at lower cost in open recirculating cooling water systems.

ENDCOR – promotes rapid film formation . . . is completely stable against oxidizing agents.

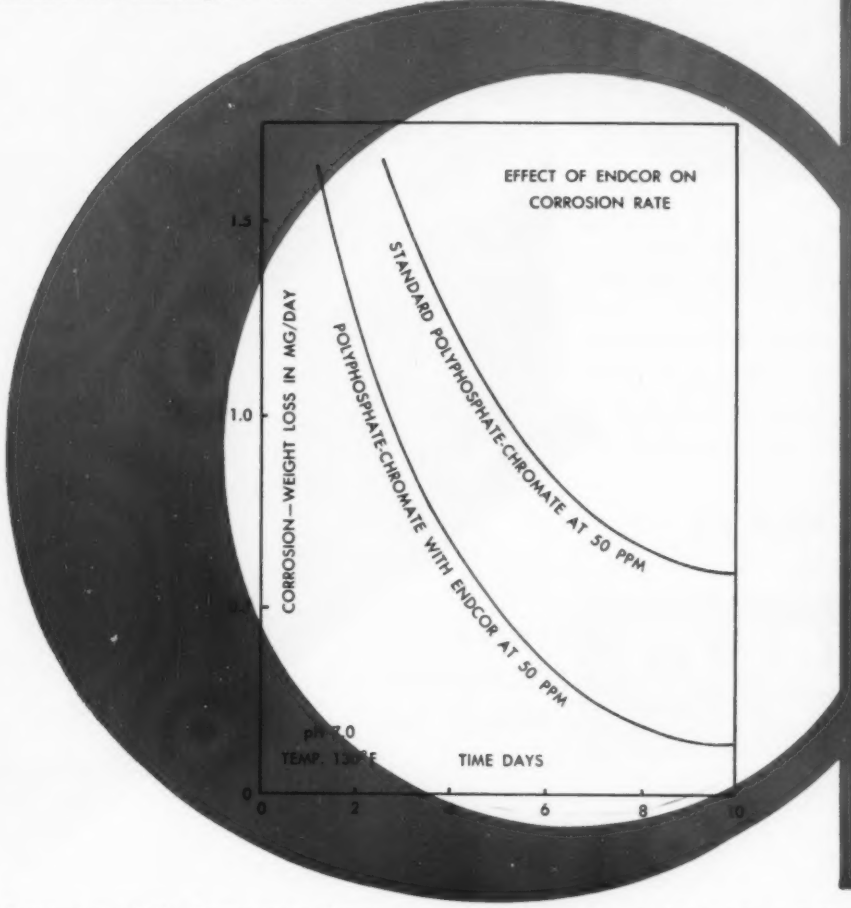
ENDCOR – sharply reduces corrosion rates and deposit formations . . . minimizes sludge adherence to heat exchange surfaces.

ENDCOR – permits operating any open system at higher pH readings . . . saves on acid.

Developed after exhaustive experiments, ENDCOR has been incorporated in Dearborn's Polychrome® and non-chromate treatments and successfully tested under severest laboratory and operating conditions in customer plants for over a year. Available now in powder or briquette form. Your Dearborn engineer will be happy to fit these new treatments to the specific needs of your system. Call him today or write for detailed Technical Bulletin.

DEARBORN CHEMICAL COMPANY

Executive Offices: Merchandise Mart, Chicago 54 • Plants and Laboratories: Chicago Linden, N. J. • Los Angeles • Toronto • Honolulu • Havana • Buenos Aires

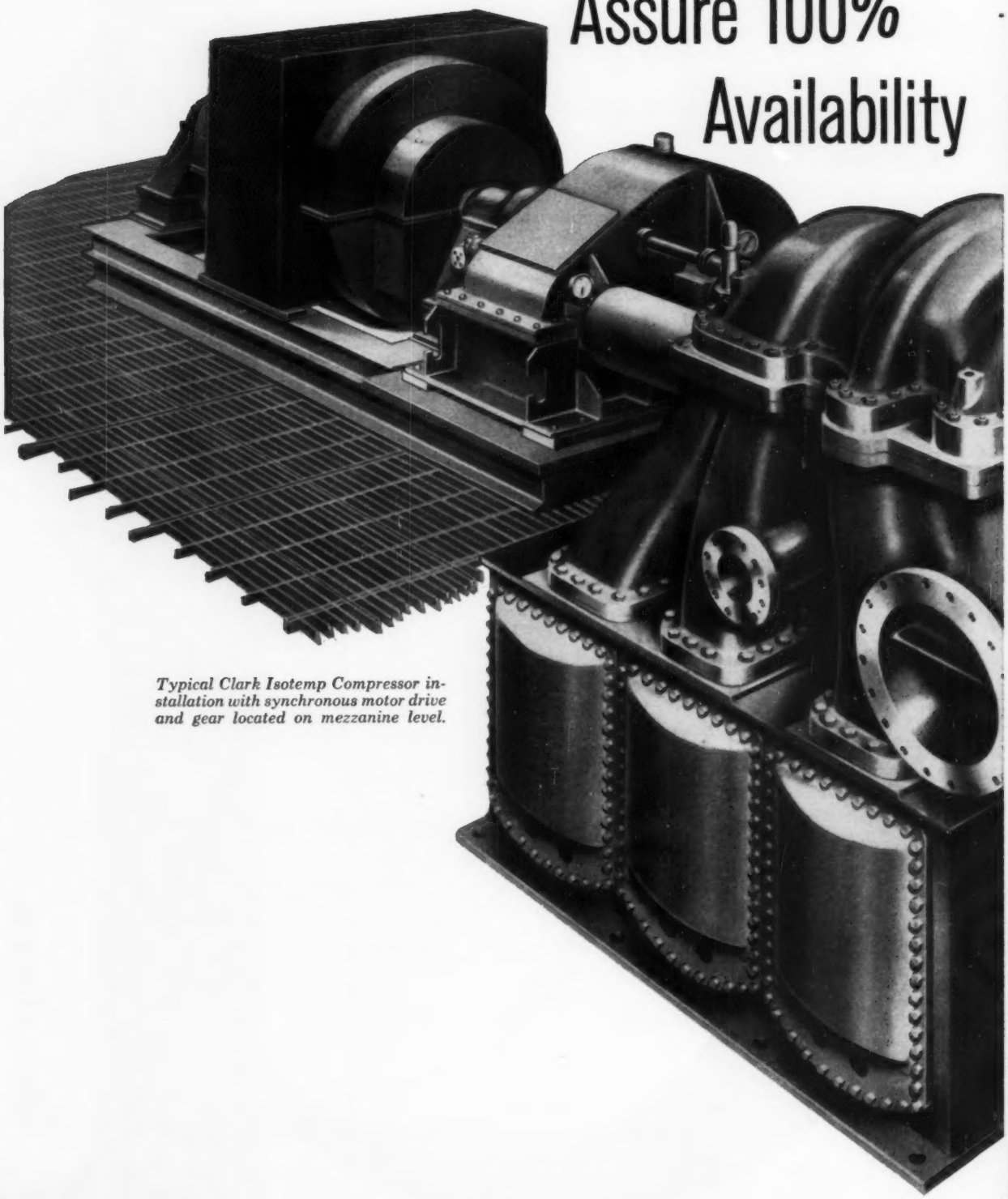


pioneer in the science of corrosion control

dearborn

For more data on advertised products, use Readers' Service Cards, last page.

CLARK Centrifugal Compressors Assure 100% Availability



Typical Clark Isotemp Compressor installation with synchronous motor drive and gear located on mezzanine level.

For more data on advertised products, use Readers' Service Cards, last page.

In air separation plants throughout the world, Clark Horizontally-Split Centrifugal Oxygen Compressors are operating in 100% service. Because the Type HS Compressors are literally maintenance free, standby units have not been required. The performance of these machines has been outstanding with safety, dependability and efficiency being among the features "best liked" by operators.

Now, another centrifugal compressor has been added to the Clark line of air separation compressors. The new Clark Isotemp Centrifugal Air Compressor has been designed to provide highest purity, primary 110 psi. air for tonnage oxygen plants. Like the Type HS Oxygen Compressors, the *Isotemp* is designed for 100% availability. It incorporates many of the design features found to be so effective in the oxygen machines.

A key feature of the Clark Isotemp Compressor is the system of integral intercoolers. Built into the base of machine, they form a compact unit-engineered package. An unusually high efficiency over a wide operating range is produced by intercooling between stages, the use of closed-type impellers and volute diffusers. Single-case, horizontally-split design assures maximum accessibility and eliminates alignment problems.

If you need high purity compressed air in large volumes, the Clark *Isotemp* will provide substantial savings in capital investment, space, foundation requirements, maintenance and operating costs. The *Isotemp* is built in seven frame sizes in packages with capacities ranging from 5000 to 50,000 cfm and more. Clark Oxygen Compressors are available in matching frame sizes. Both the Isotemp and Type HS units can be driven by synchronous motors, induction motors or turbines.

For data on Clark Centrifugal Compressors and Reciprocating Compressors consult your nearest Clark representative or write for Bulletin 175 on Isotemp Compressors, Bulletin 150 on Centrifugal Oxygen Compressors or Bulletin 160 on Clark Reciprocating Process Compressors.

CLARK BROS. CO.

OLEAN, N.Y.

ENGINES
COMPRESSORS
GAS TURBINES

CLARK
ENGINES
COMPRESSORS • GAS TURBINES

DRESSER INDUSTRIES INC.
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

For more data on advertised products, use Readers' Service Cards, last page.

Continental-Emsco

SWIVEL JOINTS..

modern joints you can

WELD

into the line!

Now you can say..

goodbye to leaky threads C-E joints welded into loading arms eliminate excessive maintenance costs caused by dripping caustic fluids.

goodbye to costly flanges C-E weldable joints eliminate need for flanged connections when fabricating loading arms.

goodbye to higher installation costs C-E weldable joints are easier and faster to install, lower priced and stronger, too.

goodbye to time-consuming packing replacement C-E weldable joints can be repacked when necessary without removal from loading arms.

Continental-Emsco's patented design permits bearings to remain in place *even during* packing replacement or adjustment. Simply loosen set screws and turn body. Joints break like a union, exposing *only* the packing . . bearings are *never* disturbed. Wide spacing of high capacity bearings . . another exclusive C-E feature . . permits greater foot-pound loading on the joint. Additional features include on-location replacement of worn parts . . elimination of split bearing races for added strength . . reversible races on most joints for double service life.

Write today for our new catalog on C-E's modern line of swivel joints.

C-E joints are manufactured for practically all petrochemical and chemical services. Sizes are available from 3/8" to 12" diameter in steel . . from 2" to 12" diameter in aluminum. Joints are also available in threaded or flanged styles for replacement in existing systems.

CONTINENTAL-EMSCO COMPANY

A Division of The Youngstown Sheet and Tube Company

Industrial Products Division
P. O. Box 359,
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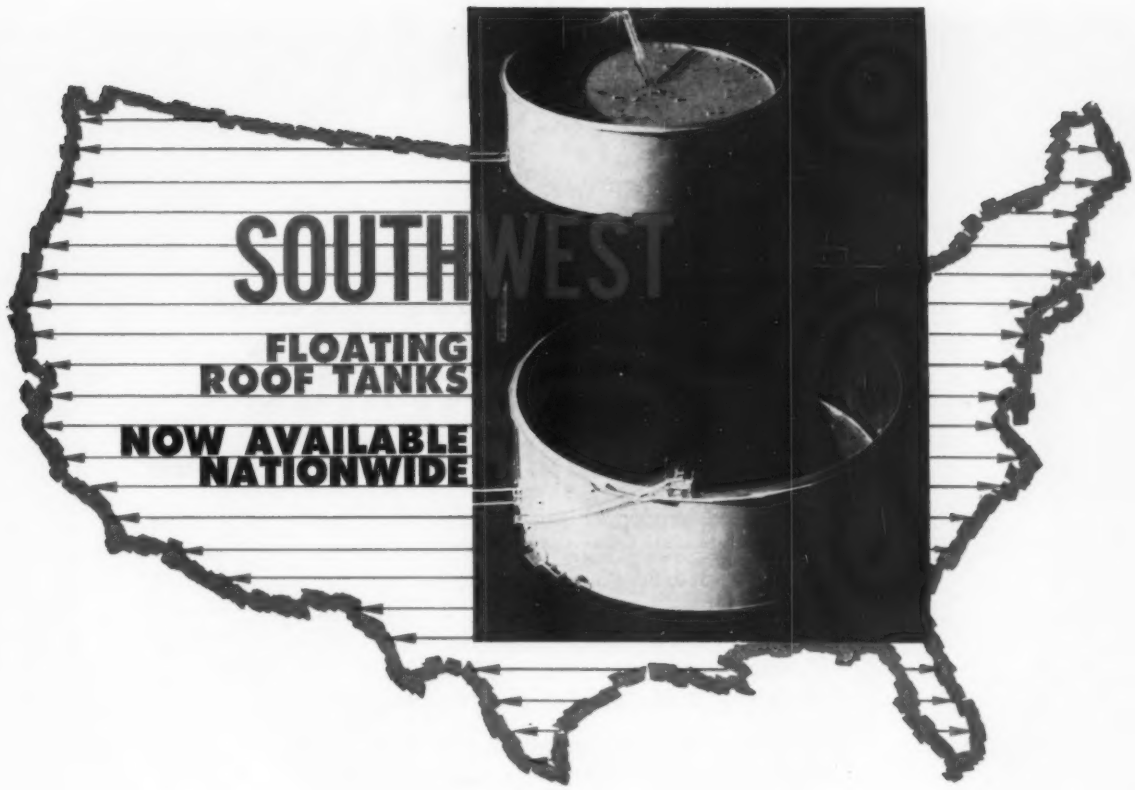
SJ002



Experienced Yuba-Southwest Crews erect these famous oil tanks—anywhere

Refineries throughout the country are now served through the experienced engineering staff, extensive fabricating facilities, and responsible field erection crews of Yuba Southwest—*operating nationwide.*

This major expansion in sales, service and erection of famous Southwest Floating Roof Tanks has been brought about through Yuba's program of planned diversification and integration of the last several years. It has greatly broadened Yuba's scope of activity and geographical service area in this highly specialized field.

Before you plan your next tank installation, get in touch with Yuba. See how the capabilities of this organization can be of real help to you in the most profitable solution to all your tank problems—all the way from design to erection.

Get acquainted with all the features of famous Yuba Southwest Floating Roof Tanks. Full description is contained in Bulletin No. FRT 59-1, yours on request.

Other Southwest products for the petroleum industry include columns of various types, reactors, regenerators, vacuum towers, catalytic reforming towers, catalytic reforming units, high pressure vessels, kilns, retorts and "Dewar-type" vessels.

specialists in fabrication and erection of processing and storage equipment

SOUTHWEST WELDING & MANUFACTURING DIVISION

3201 West Mission Road, Alhambra, Calif.

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Cleveland • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

For more data on advertised products, use Readers' Service Cards, last page.

PENNSALT SERVICE *helps you get*
PROVED SAVINGS
in HYDROFLUORIC ACID alkylation

Have you looked at all the economic advantages of alkylation with hydrofluoric acid? Pennsalt's pioneering and specialization in AHF can help you realize big savings in your alkylation process: **1** Lower catalyst cost . . . **2** Elimination of spent acid problems . . . **3** Reduced acid inventory . . . **4** Lower cooling expense . . . **5** Shorter reaction time . . . **6** Faster catalyst settling . . . **7** Minimum side reaction products.

Pennsalt's expert technical aid will show you how to use and handle AHF safely and with confidence. We'll advise you on storage . . . on the selection of valves, pumps, piping and materials of construction . . . help you with employee training programs . . . give you personalized technical assistance tailored to your needs. Talk it over with your Pennsalt representative, or write for full information.

New HF Handling and Data Book . . . includes engineering data, handling and storage information. Write on your letterhead for Bulletin S-148.

See our complete listing in Chemical Materials Catalog

Industrial Chemicals Division

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Pennsalt Chemicals
ESTABLISHED 1850

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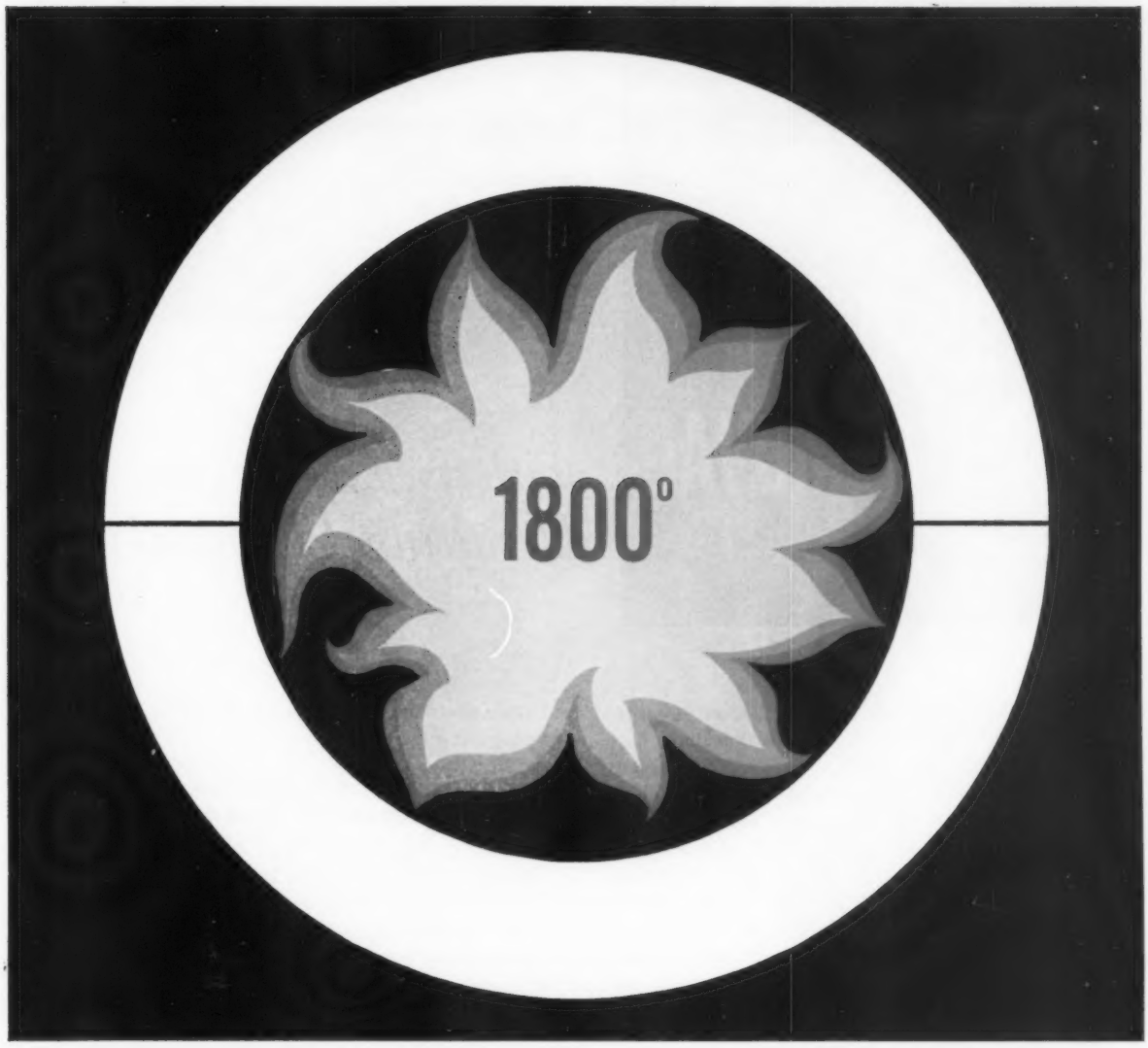

NOW CALSILITE-HI TO 1800°F

New Ruberoid Calsilite-Hi insulation for soaking heat to 1800°F. It's light, strong and so economical it can be used on all types of jobs. Calsilite-Hi is ideal for both insulation and fireproofing.

Calsilite-Hi, a molded calcium silicate insulation, extends the Ruberoid insulation line to the upper temperature limit of 1800°F. Available in half-sectional, three segmental and block form, it can be used as fireproofing for walls, partitions and ceilings as well as insulation for piping and equipment.

Calsilite-Hi is light and easy to install. It cuts and mitres quickly, smoothly and is gentle on hands. What's more, it keeps its strength even when wet, does not soften or fall off. Returns to its original thermal efficiency when dry. Resists most chemicals and alkalis in industrial concentrations.

For additional specifications or samples of Calsilite and Calsilite-Hi insulation, write: The Ruberoid Company, 500 Fifth Avenue, New York 36, New York.

THERMAL CONDUCTIVITY
(BTU/sq. ft./inch/hr./°F.)

400°F. (Mean)	0.54
600°F. (Mean)	0.64
800°F. (Mean)	0.74

Density 13.5 lbs. per cu. ft.

Compressive Strength
5% deformation (Min.) 135 lbs. psi.

Flexural Strength 75 lbs. per sq. in.

Change under Soaking Heat
24 hrs. @ 1800°F.

Loss in weight	5%
Linear Shrinkage	1.5%

The RUBEROID Co.®

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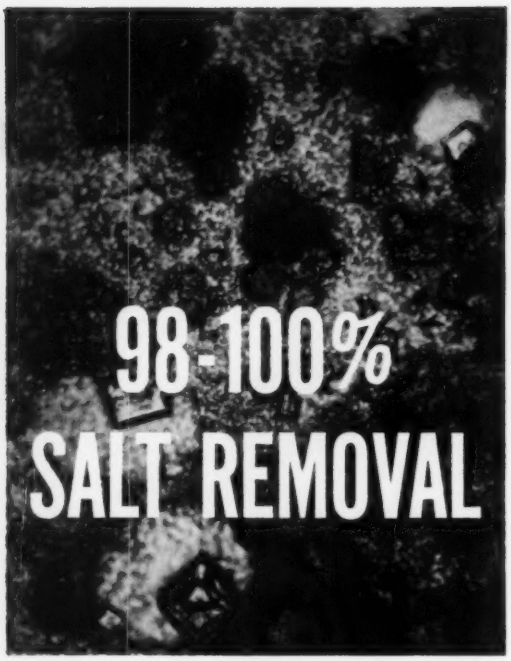

another
TRETOLITE SERVICE
report

with TRET-O-LITE *Desalting Chemicals*

It should be standard practice in modern refining to desalt any charge stream that contains 20 pounds or more of salt per 1,000 barrels of crude. Some refinery processes have an even lower salt tolerance—and permissible salt levels are constantly being revised downward. The proper application of TRET-O-LITE* Desalting Chemicals gives a clean charging crude that is 98–100% free of impurities, which would otherwise enter the refinery system and cause salt plugging in condensers, exchangers, and towers. There are important reasons why so many refiners prefer TRET-O-LITE Desalting Chemicals for this vital operation:

TRET-O-LITE DESALTING CHEMICALS ARE EFFECTIVE

Tretolite pioneering developed the first desalting system in which chemical alone provided emulsion destabilizing action. This leadership is maintained today through a never-ending research program which continues to find versatile new compounds capable of meeting every desalting condition.

TRETOLITE DETERMINES EXACT REFINERY NEEDS

Tretolite laboratory tests determine the TRET-O-LITE formulas and quantities that will desalt your particular crude most effectively. The Tretolite engineer is always available to handle new tests at site as they are required. Continuous, dependable salt removal is assured.

TRET-O-LITE Desalting Chemicals efficiently purify more than 1,500,000 barrels of crude every day, at an average cost of 1.3 mills per barrel. *Let the Man in the Red Car prove why Tretolite offers the best desalting service for your refinery.*

Equipment for Tretolite chemical desalting, as well as Petreco electric desalting, is designed and distributed by Petreco Division of Petrolite Corporation.

*Registered Trademark, Petrolite Corporation

TD-60-1

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CORPORATION

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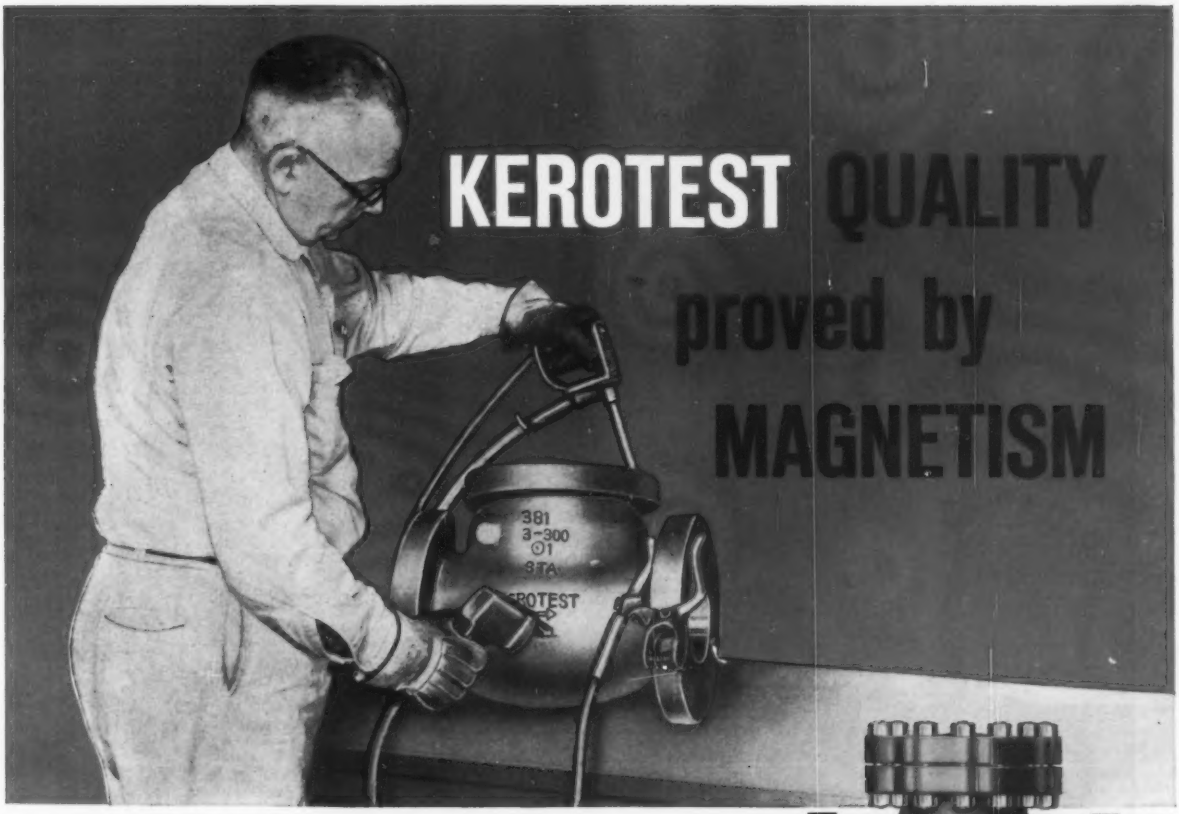


This veteran Kerotest inspector is setting up a flaw-finding magnetic field between the two electrodes. He'll cover every inch of the casting – electronically seeking out minute and hidden cracks, sand holes and other potential failure points. This swing check valve body must receive his unqualified stamp of approval before it is accepted.

Magnetic particle inspection is one of more than half dozen laboratory and manufacturing quality control procedures at Kerotest. Kerotest standards of quality insure *consistent* production of trouble-free valves. A Kerotest valve in the line is your best insurance against costly down time . . . your best protection against failure in critical and hazardous applications.

Kerotest Cast Steel Swing Check Valves

High quality Kerotest cast steel swing check valves are available in primary service pressure ratings ranging from Series 150 to Series 1500. They are supplied in all regularly used sizes for all types of service in oil, gas, steam, water, chemical, petro-chemical, marine and industrial installations.

Send for your free copy of the new, informative Kerotest booklet. It's packed with working tables, dimensions, specifications and other helpful information.

KEROTEST
Quality Controlled Features

- Durable wall sections for maximum safety
- Designed to permit passage of line scraper equal to inside diameter of pipe
- Threaded bottom seating type rings made to allow full flow, obstruction-free passage
- Rigidly supported disc allows self-alignment
- Counterbalanced discs available for minimum pressure applications

There is a Kerotest Cast Steel Valve available for every class and condition of service

KEROTEST MANUFACTURING COMPANY
2514 LIBERTY AVENUE • PITTSBURGH 22, PA.
In Canada . . . Kerotest Cast Steel Valves are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario, Canada

KEROTEST®

For more data on advertised products, use Readers' Service Cards, last page.

'62 COULD BE
THE YEAR
FOR YOU!

how to make octanes come clean . . .

Most refiners these days are called upon to make relatively high-octane motor fuel to meet current market demands. But high octanes alone are not enough. Motorists also want gasoline that burns clean!

By means of new and improved processing techniques it is now possible to produce high-octane blending components that give you the kind of gasoline motorists want. In addition to high-octane rating, these components possess excellent combustion and performance characteristics especially tailored for modern high compression ratio engines.

In order to help refiners realize their maximum potential, UOP makes available the wide variety of processes described on the opposite page. UOP technical, economic and market specialists are also available to help you determine which will best meet your existing and future needs. Ask us for a preliminary proposal, at no obligation.

INFORMED OPINION indicates that 1962 will require a substantial increase in process capacity . . . NOW is the time to start your planning!

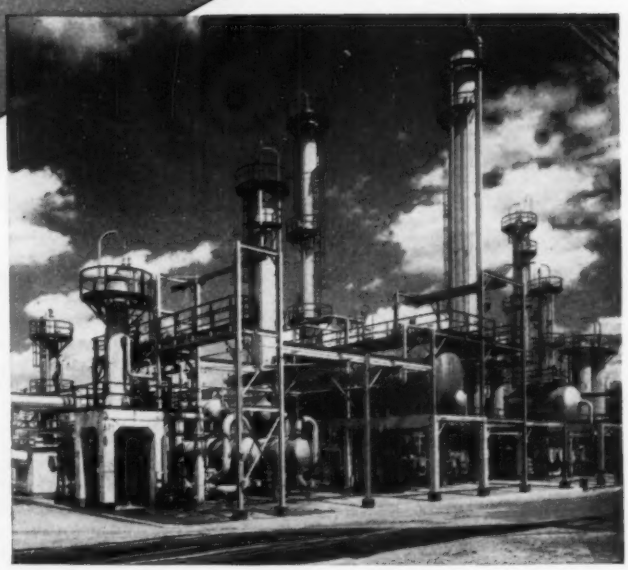
UOP® UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.
WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

"HF" ALKYLATION

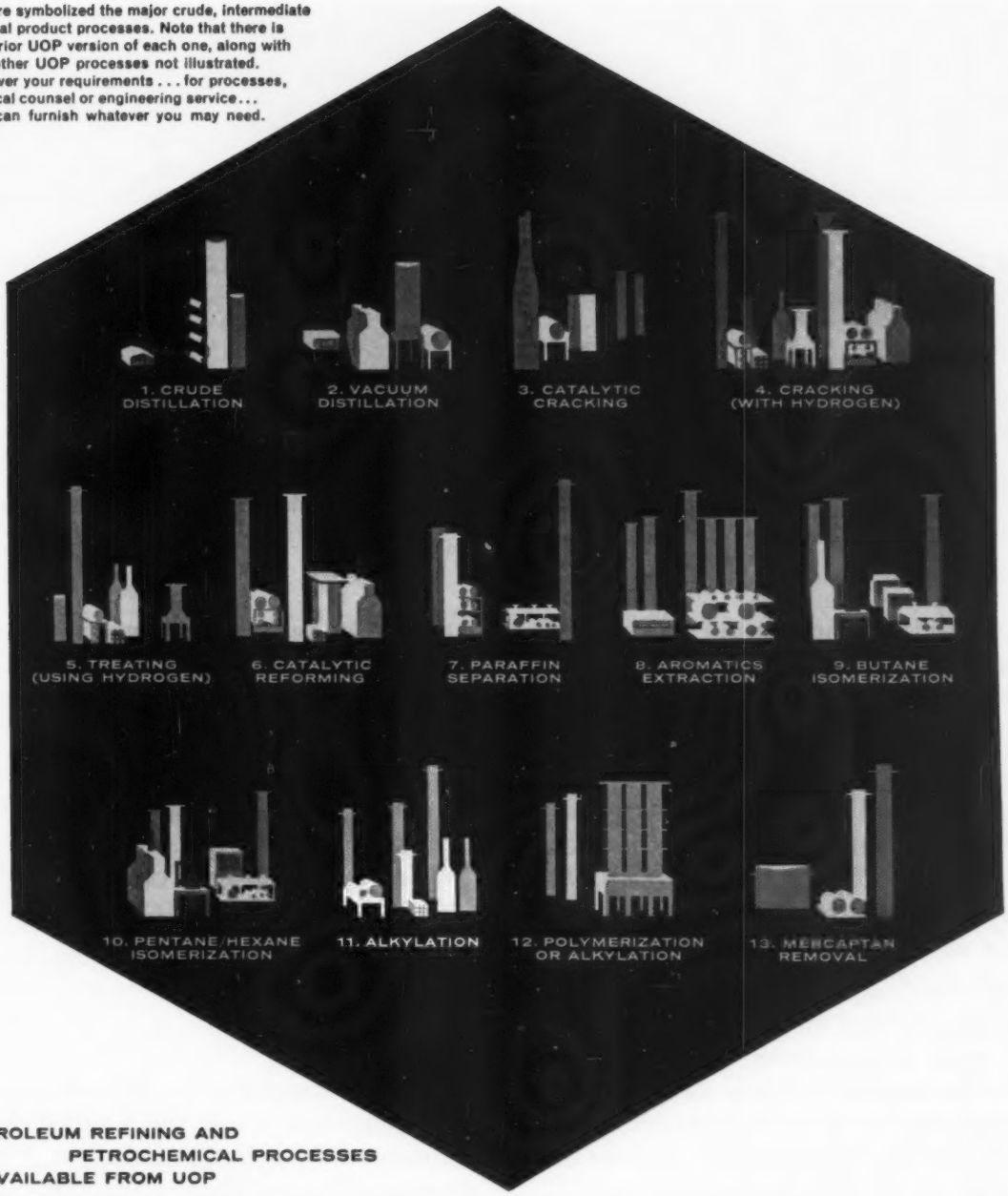
Here is a catalytic process that enables the refiner to produce an isoparaffin fuel component that burns with a minimum of carbon deposit . . . greatly reduces surface ignition and consequent rumble . . . is ideally suited to today's high compression auto engine.

Developed and licensed by UOP, "HF" Alkylation combines olefins such as propylenes, butylenes and amylenes with isoparaffin, usually isobutane. The component thus formed, alkylate, is a mixture of branch chain hydrocarbons of higher molecular weight. It is widely used in producing high octane aviation gasoline, as well as an anti-rumble component in motor fuel.

An ideal companion process to "HF" Alkylation is the UOP Butamer™ process for producing isobutane.



Here are symbolized the major crude, intermediate and final product processes. Note that there is a superior UOP version of each one, along with eight other UOP processes not illustrated. Whatever your requirements . . . for processes, technical counsel or engineering service . . . UOP can furnish whatever you may need.



PETROLEUM REFINING AND PETROCHEMICAL PROCESSES AVAILABLE FROM UOP

1. CRUDE DISTILLATION equipment is designed and engineered by UOP in any desired capacity.

2. VACUUM DISTILLATION and **VISBREAKING**—easy-to-operate processes for preparation of feed stocks for catalytic cracking.

3. FLUID CATALYTIC CRACKING—an improved process that gives higher yields, higher octane numbers.

4. LOMAX™—highly flexible process that converts middle distillates and vacuum gas oils into gasolines and distillate fuels of outstanding quality.

5. UNIFINING™—a modern process that completely purifies petroleum distillates.

6. PLATFORMING® produces high octane gasolines, high purity aromatics.

7. MOLEX™—a new continuous separating process that removes lowest-grade hydrocarbons from gasoline.

8. UDEX®—the ideal process for separation of super-purity aromatics.

9. BUTAMER™—a new and practical process for producing isobutane.

10. PENEX®—a new process that converts light, normal paraffins to isoparaffins.

11. HF ALKYLATION—makes alkylate, top anti-rumble motor fuel. Sulfuric acid process also available.

12. CATALYTIC CONDENSATION—converts olefin fractions of refinery gases into high-quality gasoline and petrochemicals.

13. MEROX™—a new and inexpensive treating process to remove mercaptans from gasolines and light distillates.

PROCESSES NOT ILLUSTRATED:

REXFORMING®—the ideal process to insure your top octane position.

CATALYTIC DEHYDROGENATION—removes hydrogen from hydrocarbons to produce less-saturated hydrocarbons.

HYDEAL™—a new process for the hydrodealkylation of toluene or C_8 aromatics to produce benzene; may also be used for manufacturing phenol and naphthalene.

HYDRAR™—converts benzene to cyclohexane with excellent yields, achieves extreme high purity with Udex grade benzene.

OLEFIN EXTRACTION—efficiently separates olefins and diolefins from paraffins; prepares olefins for further conversion.

AROSORB™—removes heavier aromatics from synthetic and natural distillates, produces aromatic-free heavier distillates.

ALKAR™—produces ethylbenzene, cumene and other alkylated aromatics from Fluid Cat Cracker off-gas streams.

UNISOL®—an economical process for treating high mercaptan-containing gasolines.

For more data on advertised products, use Readers' Service Cards, last page.

WHERE DO YOU STAND ON COMPUTER CONTROL— LEADING OR LAGGING?

Far-sighted leaders in industry are realizing the benefits made possible by applying computer control systems to their processes.

Working with these leaders, General Electric has already pioneered the application of twenty on-line GE-312 computer systems now being implemented in these basic areas —STEEL, ELECTRIC UTILITIES, CHEMICAL, CEMENT, and PRODUCTION CONTROL for various manufacturing applications.

The GE-312 Computer Control System embodies adaptability and flexibility to meet many types of applications in varying size plants. For example, compare its expansible memory—capacity up to 52,000 words. Compare its flexible input/output—capable of scanning up to 1500 instrument inputs. These are maximum capabilities, expansible from a minimum system. You buy a system tailored to your exact requirements.

Add to this versatile equipment the computer systems engineering ability demonstrated by General Electric in implementing these twenty GE-312 system applications.

Add also the long history of General Electric overall systems know-how—its broad background in the equipment, processes and materials to which you apply computer control.

Tomorrow's profits will come from today's combination of vision, equipment, and know-how. *Where do you stand?*

There are General Electric Sales and Application engineers in over one hundred offices throughout the nation to serve you. *Phone* the nearest General Electric Apparatus Sales Office, or *wire* General Electric Computer Department, 13449 North Black Canyon Highway, Phoenix, Arizona.

PROCESS CONTROL
AUTOMATED BY GENERAL ELECTRIC

Progress Is Our Most Important Product

GENERAL ELECTRIC

CPA-50 (9-60)

General Electric—a pioneer in computer systems for all phases of business, industrial, scientific, engineering, and financial endeavor.

CONTACTOR NUMBER 2

GLYCOL PROCESS DESIGN AND OPERATING INFORMATION

Proper use of glycols in well designed, correctly operated equipment is essential for efficient gas treating. Some of these important design and operating considerations will be discussed in this series.

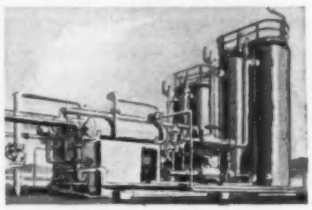
Glycol Injection Units

Units discussed in this issue of Allied Chemical Contactor are those using glycols to prevent hydrate formation when low temperatures are used to increase recovery of liquifiable hydrocarbons.

Type of Glycol for Use

Either ethylene or diethylene glycol may be used in glycol injection recovery units. Triethylene glycol is *not* recommended because of its high solubility in liquid hydrocarbons.

Both ethylene and diethylene glycol offer certain advantages depending on desired characteristics. Ethylene glycol has a higher vapor pressure, which means a greater vapor loss . . . yet it has a lower solubility in liquid hydrocarbons. Thus, losses are essentially equal for both chemicals. Ethylene glycol is less viscous than diethylene glycol, and its eutectic mixture with water has a lower freezing point than does the diethylene glycol eutectic.



Separation of Glycol and Hydrocarbon

Optimum temperature for separation of glycol and hydrocarbons is in the range of 40-60° F. High losses can occur if the streams are heated above 100° F prior to separation. At the other extreme – temperatures below 20° F – it is very difficult to separate glycol and hydrocarbon streams because they are practically insoluble. Entrainment of the glycol in the exit hydrocarbon stream will cause high losses of glycol. If it *is* mandatory to separate at low temperatures, long residence times or very efficient agglomerating separators should be used.

Amount of Glycol to Inject

To prevent hydrate formation, it is possible to inject as little as one-half gallon per hour per mmcfd; for greater dehydration, most operators prefer to inject one gallon of glycol per hour per mmcfd.

Mechanics of Injection

Use of spray nozzles for atomization of the glycol when it is introduced into the natural gas is recommended. Operating experience has shown that several joints of pipe will effect a very thorough mixing of glycol and gas, provided flow is in the turbulent region.

Care should be taken to prevent layering of glycol where the chiller is of the shell and tube type. Assure complete mixing of the glycol in the gas.

Care of Glycol

Like any process, good operation dictates that proper care be taken of the glycol used for hydrate inhibition. Frequent checks on the pH of the glycol should be made. Practically all of the degradation products of glycols are acids, being predominantly formic and acetic acid; and though none have been reported, it seems likely that dibasic acids could be produced by degeneration. If the pH of a glycol unit is not carefully watched the solution can become very acidic which will cause the solution to be corrosive. A buffer should be employed that will keep the pH at 7.2.

A black gum very often forms in glycol units. The presence of hydrocarbons seems to speed the rate of formation of this material, and hydrocarbons may be a reactant. The formation almost always occurs at a low pH and could be an ester (or even possibly a polyester). This material when deposited is very hard and brittle, but exists in the glycol as a very fine suspension. We believe that the removal and control of tnis material is essential to proper glycol unit operation.

In most of these systems a very convenient buffer is monoethanolamine. MEA is a fairly strong base and will yield soluble salts with the acids formed in these units. Another reason for the use of MEA is that it is a film former and will serve as a corrosion inhibitor. Care should be exercised when using MEA in this manner so that too much is not used. At a pH of around 8.5, a solution of glycol and MEA may foam very badly.

Another important step to be taken in the care of glycol solutions is the proper filtration of the solution. As mentioned, an accumulation of gum and silt in a glycol solution is an invitation to trouble. Glycol is a very difficult material to filter and one possible way might be to use a self cleaning type filter in combination with a packed filter. Longer and more complete operation would be obtained in this manner.

FOR MORE INFORMATION, look for future issues of Allied Chemical Contactor featuring articles on ethanolamines and glycols in gas treating operations.

We will gladly send technical data, delivery and price information on Allied Chemical Ethanolamines and Ethylene Glycols.

For specifications and local offices, see our insert in Chemical Materials Catalog, pages 475-482 and in Chemical Week Buyers Guide, pages 37-44.

BASIC TO AMERICA'S PROGRESS

Allied Chemical

NITROGEN DIVISION

Dept. C2-21-1, 40 Rector Street • New York 6, New York

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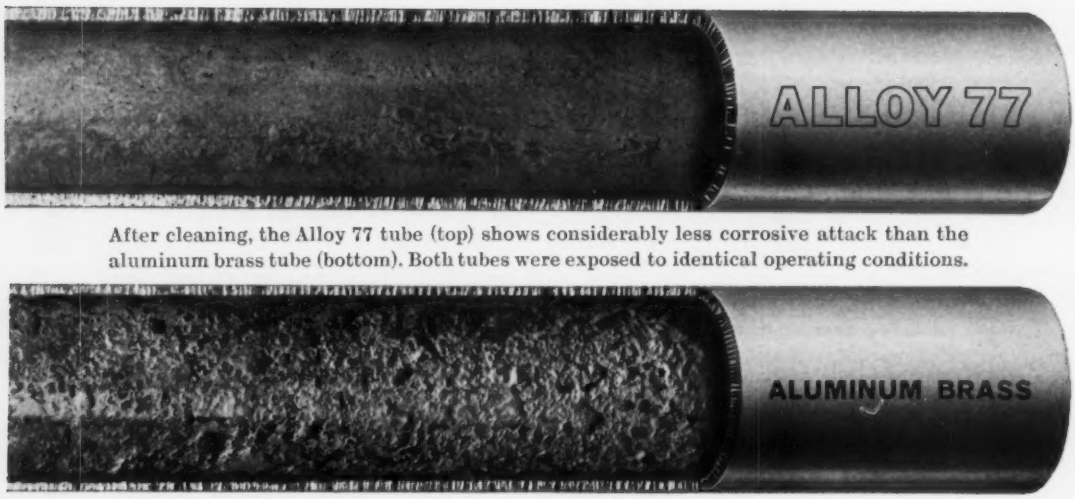
BRIDGEPORT ANNOUNCES

ALLOY 77*

new condenser tube alloy radically reduces biofouling



After cleaning, the Alloy 77 tube (top) shows considerably less corrosive attack than the aluminum brass tube (bottom). Both tubes were exposed to identical operating conditions.

Metallurgical history is being made by Bridgeport's use of Mercury as the corrosion inhibitor in Alloy 77, the first completely new condenser-tube alloy developed in years. Startling advantages for this alloy have been uncovered during 18 years of continuous laboratory and field service tests.

Alloy 77 does what has never been done before in the control of biofouling. The Mercurial Brass Alloy kills living biorganisms before they have a chance to attach themselves to tube interiors. Costly chlorination treatments are reduced and no unusual cleaning methods are needed.

Chlorine Dollars, Cleaning Dollars, Lost Heat Transfer Efficiency Dollars can be saved when you tube or retube with Bridgeport Alloy 77. Full details can be had immediately from our Technical Data Folder. A request to Dept. 5309 for "77" will get you your copy.

*U.S. Patent No. 2,887,374, May 19, 1959

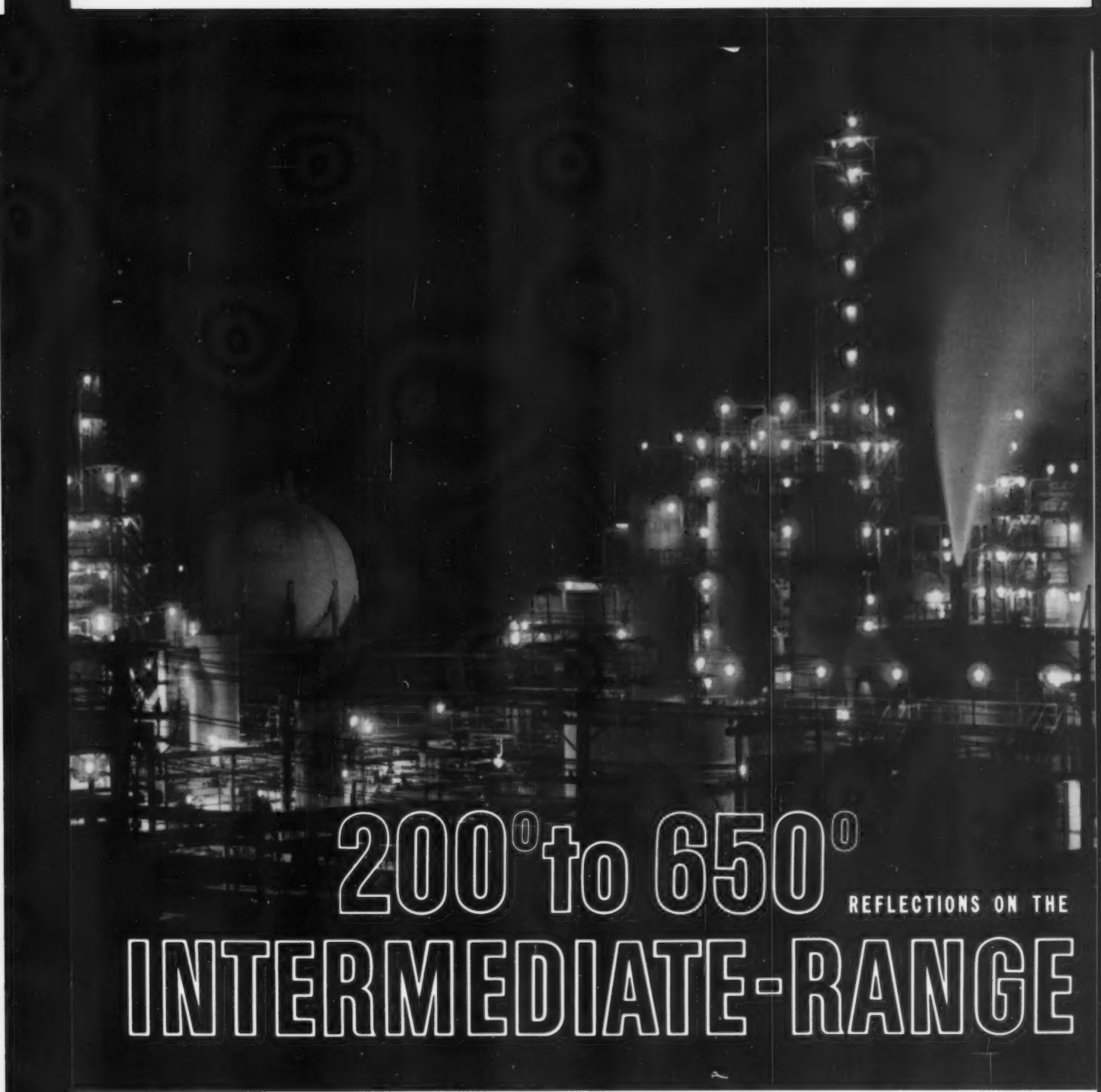
The advantages of Alloy 77 have been proven time and again in sea water, fresh water and brackish water. Check these advantages:

1. **Radically reduced biofouling**
2. **Higher transfer efficiency**
3. **Excellent general corrosion resistance**
4. **Forms soft, thin, powdery scale**
5. **Simple, easy cleaning**
6. **Field tested performance**

BRIDGEPORT BRASS COMPANY

Bridgeport 2, Connecticut — *Specialists in Metals from Aluminum to Zirconium*

For more data on advertised products, use Readers' Service Cards, last page.

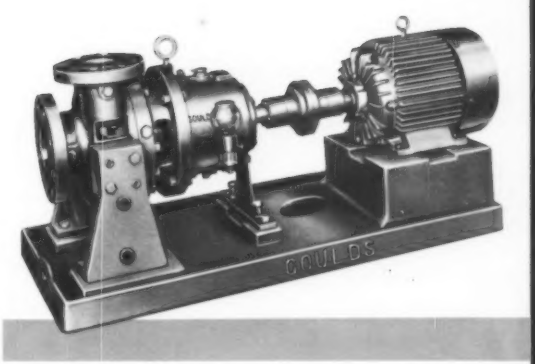


200° to 650° REFLECTIONS ON THE INTERMEDIATE-RANGE

A petroleum pumping problem lies between the temperatures of 200° and 650°F—the intermediate range. Pumps that handle these temperatures are usually built to stand far greater heat . . . and are much more pump than is needed.

Goulds has designed a petroleum process pump that fits into this critical area of temperatures like a glove . . . by adding one hundred twelve years of experience to a young and vigorous talent for matching the pump to the problem.

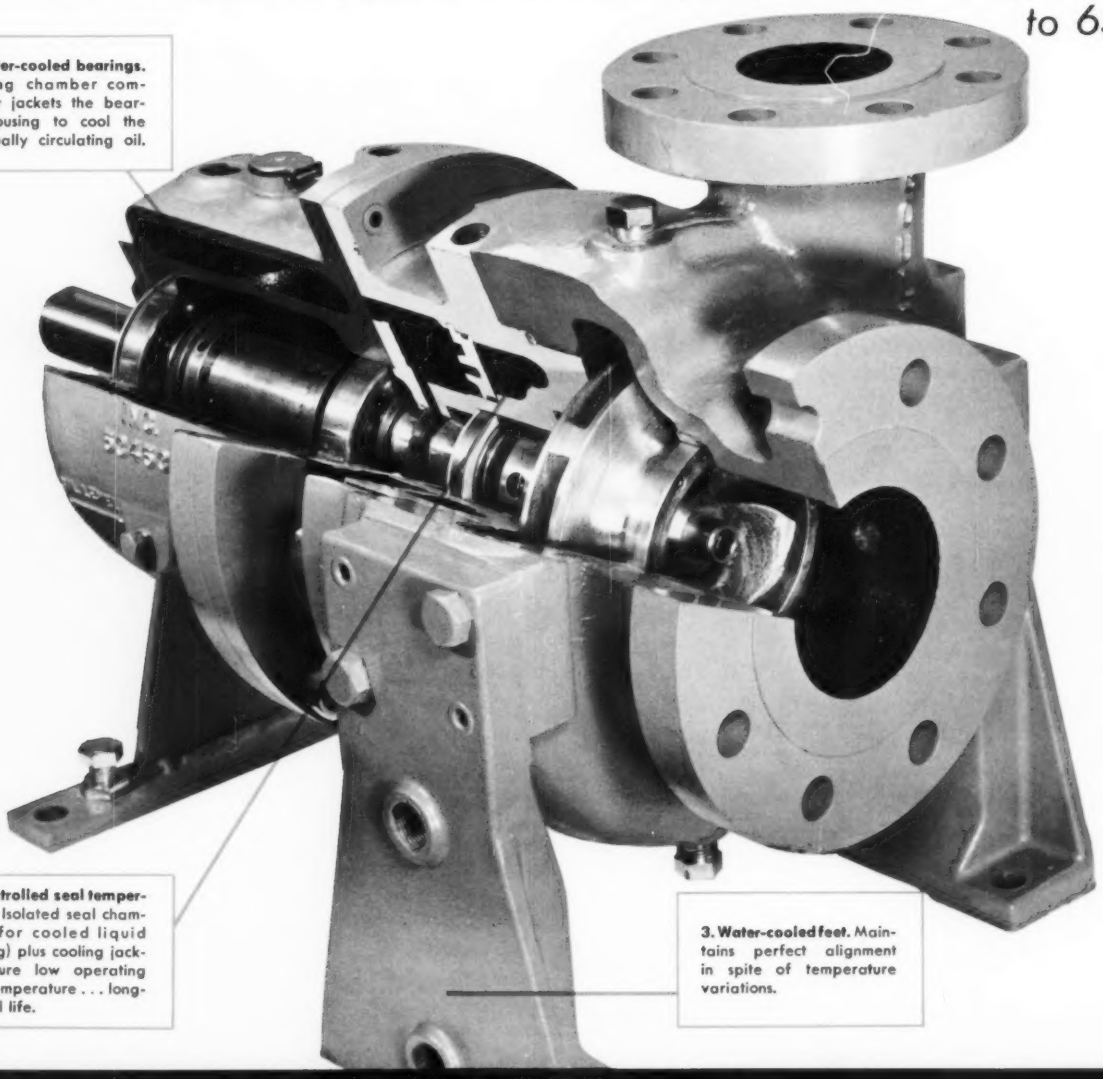
When you turn this page, you'll see inside the intermediate-range pump. And you'll get a glimpse of other Goulds pumps planned with the petroleum industry in mind.



AN INSIDE LOOK AT
INTERMEDIATE-RANGE DESIGN

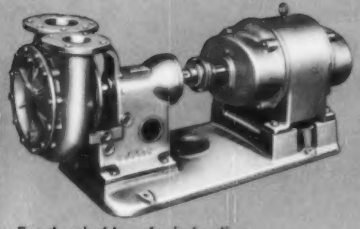
Here's why the Goulds petroleum process pump handles temperatures to 650°F

1. Water-cooled bearings. Cooling chamber completely jackets the bearing housing to cool the continually circulating oil.

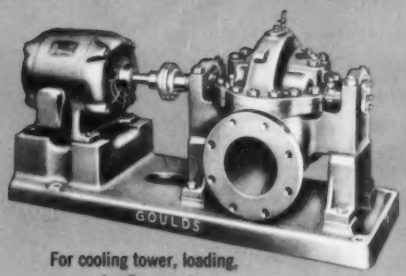


2. Controlled seal temperature. Isolated seal chamber (for cooled liquid flushing) plus cooling jacket insure low operating seal temperature . . . longer seal life.

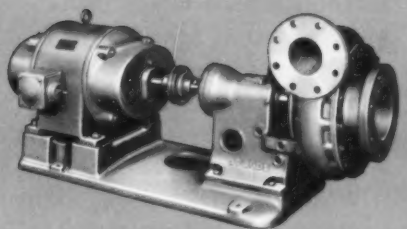
3. Water-cooled feet. Maintains perfect alignment in spite of temperature variations.



For chemical transfer in treating and lube plants



For cooling tower, loading, and reflux service



For tank farm and bulk service

Intermediate-range design lowers initial cost

Practical features cut maintenance cost

Goulds petroleum process pump Model 3775, built to API 610 specifications, gives you the economies of practical design.

Back pull-out makes seal replacement and maintenance easy. With the use of a spacer coupling, rotating parts can be removed without disturbing pipe connections or drive. *A millwright can do it alone.*

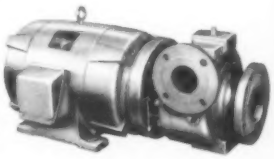
Choose your own seal design. Single, double, balanced or unbalanced mechanical seals can be supplied to suit your specific requirements.

Low spare parts inventory. All eleven sizes of the Model 3775 are built on the same bearing frame. The resultant standardization and interchangeability give you maximum economy in inventorying spare parts.

High working pressures. The Model 3775 has been designed expressly to meet the exacting requirements of the petroleum and petrochemical industries. It is an enclosed impeller-type centrifugal pump, centerline mounted with vertically split casing. It pumps a maximum of 850 gpm, handles pressures to 550 psi.

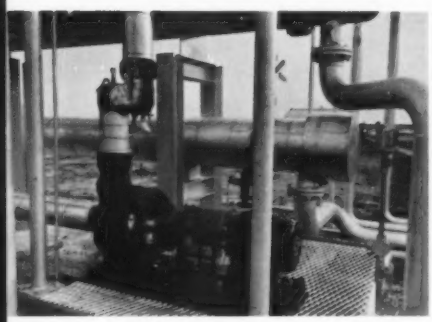
For complete specifications, construction details, and pressure-temperature chart, just send us the coupon below.

Close-coupled version



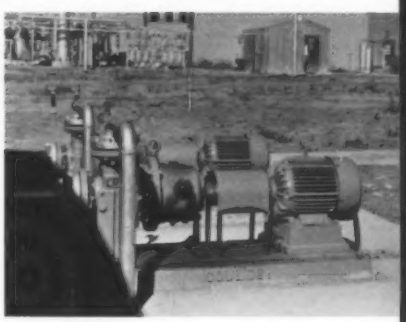
Goulds Model 3675 is a close-coupled version of the Model 3775, incorporating the same liquid end as the frame-mounted type but providing the compactness found only with integral pump-motor designs. Eleven sizes provide broad rating coverage with capacities to 850 gpm, heads to 350 ft. Maximum temperature is 275°F and maximum working pressure 550 psi.

The Model 3775 serves a broad range of applications

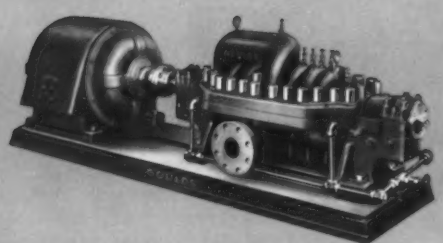


LOW TEMPERATURES. Low-temperature applications are met equally as well as high-temperature ones. Shown above is a 3775 1½x2-9 on propane-circulating service rated at 70 gpm, 210 ft, 10°F liquid. Compact casing design with internal seal flushing provides for easy lagging.

HIGH TEMPERATURES. Intermediate-range design provides a standard pump for the higher-temperature applications. Shown above is a 3775 3x4-7 on hot oil service handling 250 gpm against 130 ft. of head of 400°F oil. Bearing cooling and seal chamber cooling, standard features on these pumps, provide the essential features necessary for this engineered application.



NORMAL SERVICE. Where the need is for steel case and high working pressures, as on light ends, reflux, and intercooler service, Goulds Model 3775 is ideally suited. Shown above is a typical service handled by a pair of 2x3-7 pumps rated 150 gpm at 150 ft, propane at 100°F and 200 psi suction pressure.



For pipe line and water flood injection

For corrosives, slurries, and waste

GOULDS PUMPS, INC.

Dept. I R-60, Seneca Falls, N.Y.

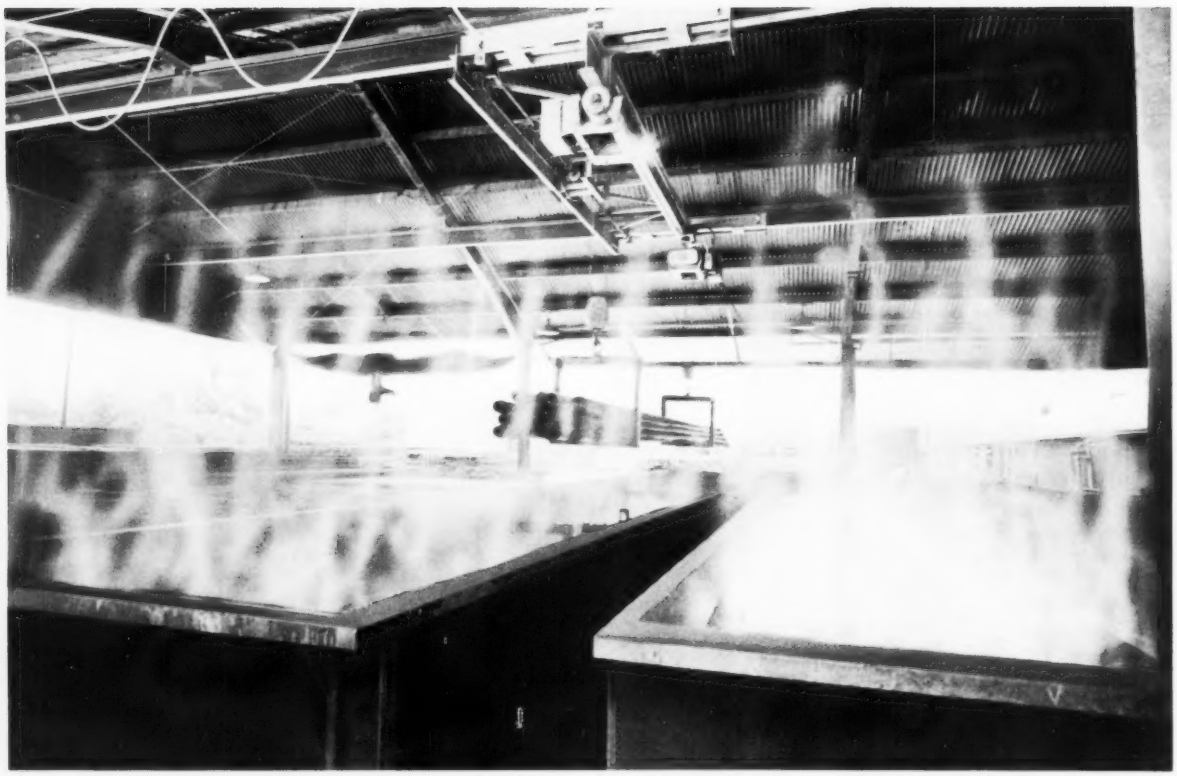
Please send me Bulletin 724.1 giving details and specifications on the Model 3775.

NAME ..... TITLE .....

COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....



AFTER 18 MONTHS
NO corrosion damage with Napko COAL TAR EPOXY

The roof and steel beams of this pickling tank shed show no trace of corrosion damage after being subjected to 18 months of constant exposure to sulphuric acid vapor and steam from hot caustic solutions. The reason: Napko's advanced COAL TAR EPOXY!

Laboratory and field tests have proved that C. T. E. gives you the greatest possible resistance to corrosion by salt water, mineral acids, alkalis, petroleum products and abrasion damage.

The exclusive Easy-Flow formula of Napko C. T. E. permits applications up to 20 mils thick without runs or sags — without expert application techniques. You save labor time and money with faster application, fewer costs. This extra heavy film bridges small crevices and rough edges, the areas where thinner films tend to fail, and gives your equipment complete pin-hole free protection.

Find out how Napko Coal Tar Epoxy can help you solve your corrosion problems. Write for more information and complete specifications *today!*

PROJECT SERVICES OF NAPKO CORPORATION

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Complete Coating Systems for every Industrial Requirement

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INDUSTRIAL COATINGS DIVISION

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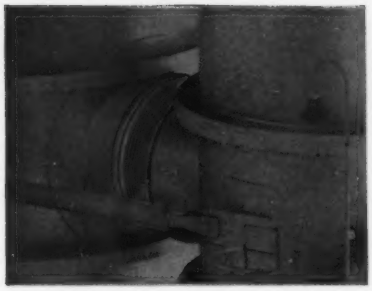
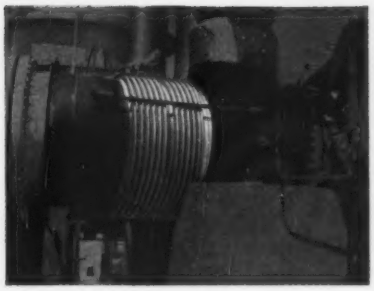
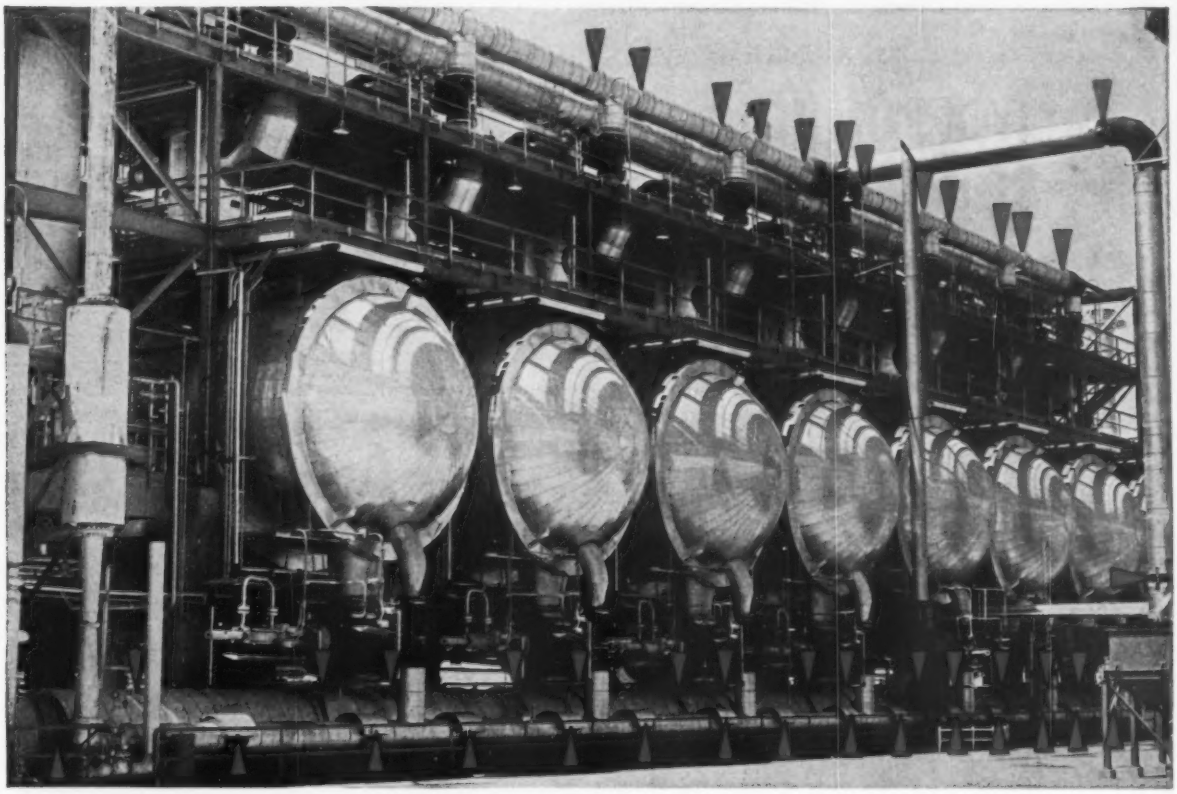


85½ in. dia. expansion joint connecting quench and pre-quench towers. Pinned structural ties permit expansion joint to absorb axial and differential vertical movement.



48 in. dia. expansion joint at compressor discharge. Double bellows permit large axial movement. Internal sleeve guide provides for stability, minimum pressure drop.

54 in. dia. hinged expansion joints in loop to pre-quench tower. They absorb 5⅜ in. vertical expansion and 7⅝ in. horizontal expansion due to 1200°F temperature in reactor header.



125 ZALLEA EXPANSION JOINTS, 125 demands for maximum reliability

Expansion joints, specially engineered and designed by Zallea, solve problems of space, heat and flow for Odessa Butadiene Co., Odessa, Texas.

Large-diameter piping (up to 72 in. dia.), with short, straight runs and critical flow conditions, posed new design problems. High temperature operation (1200°F) required minimum loading on sensitive equipment. Open-air construction, with few load carrying members dictated maximum stability of expansion joints with minimum use of external guides and anchors to support pipe weight and resist wind loading.

To solve these problems called for a competent, close-working team of process, piping and structural engineers from Fluor Corp. Ltd., design engineers from Odessa Butadiene Co., and application engineers from Zallea.

Result: A compact, reliable piping-expansion joint system that permitted containment of an efficient, 50,000 ton per year unit in an area whose largest dimension is a few hundred feet.

This is another example of how Zallea experience in handling critical, complex Expansion Joint applications can save time and money. For more facts, call us . . . or write for catalog 56.

ZALLEA BROTHERS, Taylor and Locust Sts., Wilmington 99, Del.

Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

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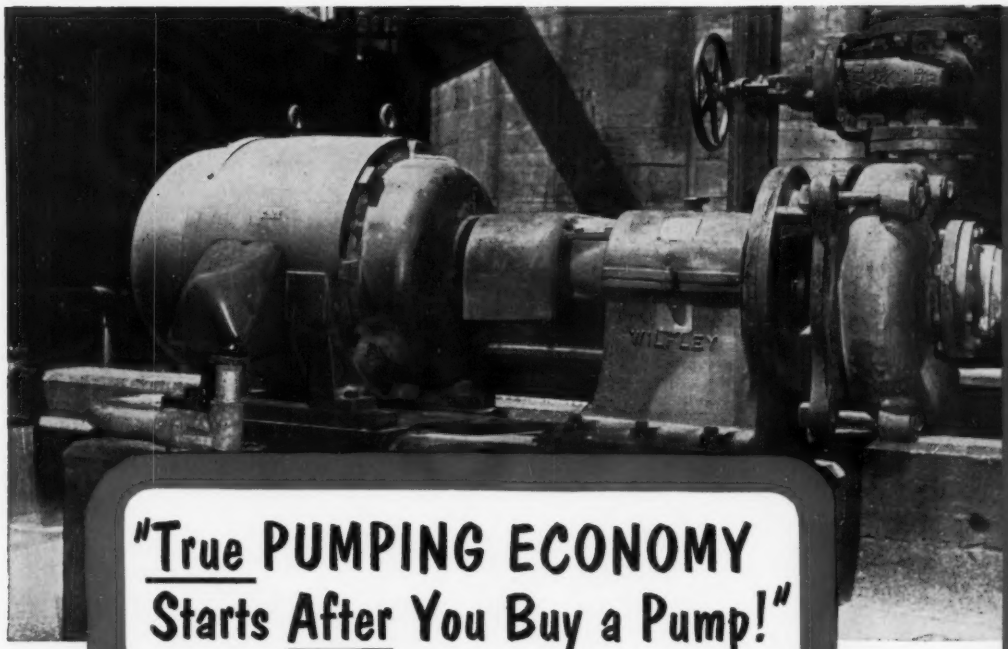

"True PUMPING ECONOMY Starts After You Buy a Pump!"

Price alone does not determine the actual value of a pump. Quality, efficiency, never-failing dependability . . . these are the prime factors a pump must have to give you true pumping economy. They pay off in low operating costs month after month, year after year.

WILFLEY ACID PUMPS

guarantee true pumping economy through CONTINUOUS, TROUBLE-FREE OPERATION WITHOUT ATTENTION, LOWER MAINTENANCE COSTS, RUGGED CONSTRUCTION, LONGER PUMP LIFE and HIGHER OUTPUT.

Whether you are pumping corrosives, hot liquids or mild abrasives, there's a Wilfley Acid Pump to do the job for you dependably, economically. Pumping parts are available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. 1" to 8" discharge sizes with 10 to 3000 GPM capacities and heads up to 200' and higher. Write, wire, or phone for complete information.

Every installation is JOB ENGINEERED

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NOW HIGH HEAT TRANSFER RATE with LOW PRESSURE DROP

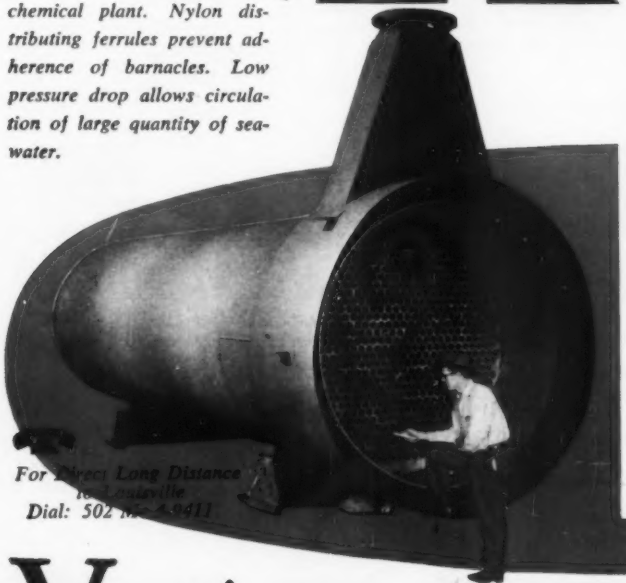
Another Vogt Engineering Achievement

*One of the many distributor types developed for various applications.**

TOP: *Muddy well water is the coolant for these Jacket Water Coolers.*

RIGHT: *Two 56" Dia. x 12'0" high Amine Solution Coolers with expansion joints in shell.*

BOTTOM: *One of a number of seawater cycle units for a chemical plant. Nylon distributing ferrules prevent adherence of barnacles. Low pressure drop allows circulation of large quantity of seawater.*



For Direct Long Distance ... Louisville Dial: 502 ... 4-9411

**Covered by Pat Nos. 2,057,597, 2,424,441 and others pending.*

Special metering distributors control the flow in vertical Vogt film type exchangers of single tube-pass design. The liquid is spread in a uniform film over the inside surface of the tubes. Since the liquid falls by gravity, good velocity is obtained with a small quantity of liquid.

Vogt has developed many types of distributors which are made from a variety of materials to accommodate the fluids circulated through the tubes in specific processing operations.

A unique feature of these exchangers is that the tube side can be cleaned while in operation.

Vogt Film Type Exchangers are used as Coolers, Condensers, Absorbers, Heaters, and Evaporators.

Other Vogt Products

Forged Steel Valves and Fittings. Petroleum Refinery and Chemical Plant Equipment. Steam Generators. Heat Exchangers. Ice Making & Refrigerating Equipment.

BULLETIN HE-8

Bulletin HE-8 describes unusual and standard Vogt Heat Transfer Equipment and is available upon request. Address Dept. 24A-XPR.

HENRY VOGT MACHINE CO.
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SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati, Los Angeles

Vogt FILM-TYPE HEAT EXCHANGERS

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At Mount Rushmore National Memorial in South Dakota small fissures in the sculptured faces of Washington, Jefferson, Lincoln and Roosevelt are being sealed with granite dust and white lead. Though the granite sculpture is estimated to last for thousands of years, this preventive maintenance will keep the surfaces smooth and slow the natural erosion process. The insert shows how workmen are suspended on Union Wire Rope.

Tuffy is an old hand at new ideas

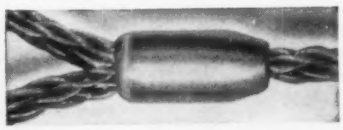
Whether it's better equipment for drilling deeper oil wells, or doing a "preventive maintenance" job like the one shown above, new needs for slings and wire rope are constantly coming along.

Tuffy meets these needs with products perfectly "tailored" to the job at hand. Products that give the ultimate in working efficiency, safety and long service life — at the ultimate low cost.

In Union research laboratories the quest is continuous for new ideas and new ways of making wire rope and slings. It's been that way for more than 30 years. Out of that research have come such important advances as Tuffy's 9-part machine-braided sling, famous for its unmatched combination of strength and flexibility.

Here are Tuffy "extras" you get at no extra cost

Tuffy's patented 9-part machine-braided fabric is a marvel of strength and flexibility. It makes knotting and kinking next to impossible. If a kink should occur, it's easily smoothed out, leaving no permanent damage.



Tuffy's pressed-on metal ferrule gives the tucked eye splice 100% of fabric strength. It's applied under tremendous hydraulic pressure — and streamlined to eliminate snags that might injure hands and arms.

For products you trust, service you rely on, the man to see is your Tuffy Distributor. Look him up in the Yellow Pages.

Tuffy® Tips
— on safe use of
Slings and Hoist Lines

Safety in Hoisting Saves Costly Injuries

During a recent 12 months period, back injuries resulting in lost time totalled 32,643 in one state (California). Lost-time injuries caused by strain or over-exertion: 24,639. A high price to pay—in misery and money—for lifting, pushing and carrying loads.

Proper hoisting equipment, properly used and maintained, is one important answer to this injury problem. It may save your workers disabling accidents, and save you expensive absenteeism and lost production.

Rules for Safe Use of Hoists

1. *Don't let muscles* do what a proper size hoist should do.
2. *Adequate hoists* aren't expensive. With proper slings and hoist lines, they will help a lot in reducing injuries to workers.
3. *Use the right sling* and hoist line for the job. Tuffy slings and hoist lines are tailored to every need, from the smallest block and tackle to giant cranes and other equipment.
4. *Don't assume* that all slings are right for all kinds of lifting. Your Tuffy distributor will help you select the right ones.

FREE!
New Tuffy Sling Handbook

Covers the subject from A to Z. All types, weights, dimensions, rated loads and other data for slings and sling fittings. Write **Union Wire Rope Corporation, 2284 Manchester Ave., Kansas City 26, Mo.** Specialists in high carbon wire, wire rope, braided wire fabric and stress-relieved wire and strand.

5

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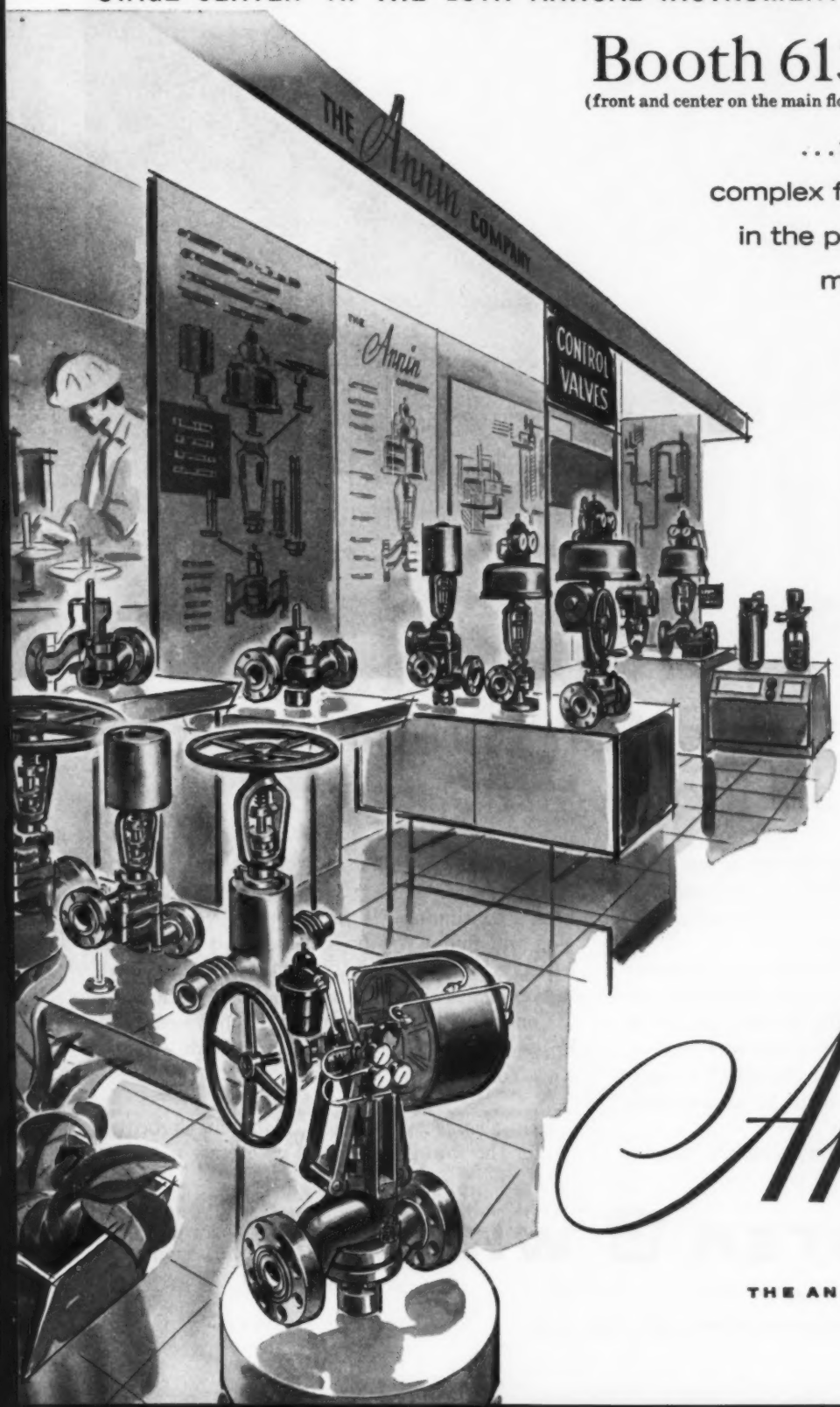
Booth 613

(front and center on the main floor)



...the proven answer to
complex fluid control problems
in the process industries and
missile ground support

Always the center of attraction where the newest control valve concepts are sought, ANNIN brings to this year's Instrument-Automation Show new designs... new solutions... to complex control problems for industry and the military. On display—an improved standard valve line augmented by custom-built electro-hydraulic and pneumatic-hydraulic actuators. For missile and space vehicle ground support, Annin presents for the first time a self-draining valve for storable propellants, and a new vacuum jacketed valve for the control of liquid hydrogen. Check ANNIN first...and discover why no other line of valves and actuators offers so much in design and performance features.

Annin
VALVES

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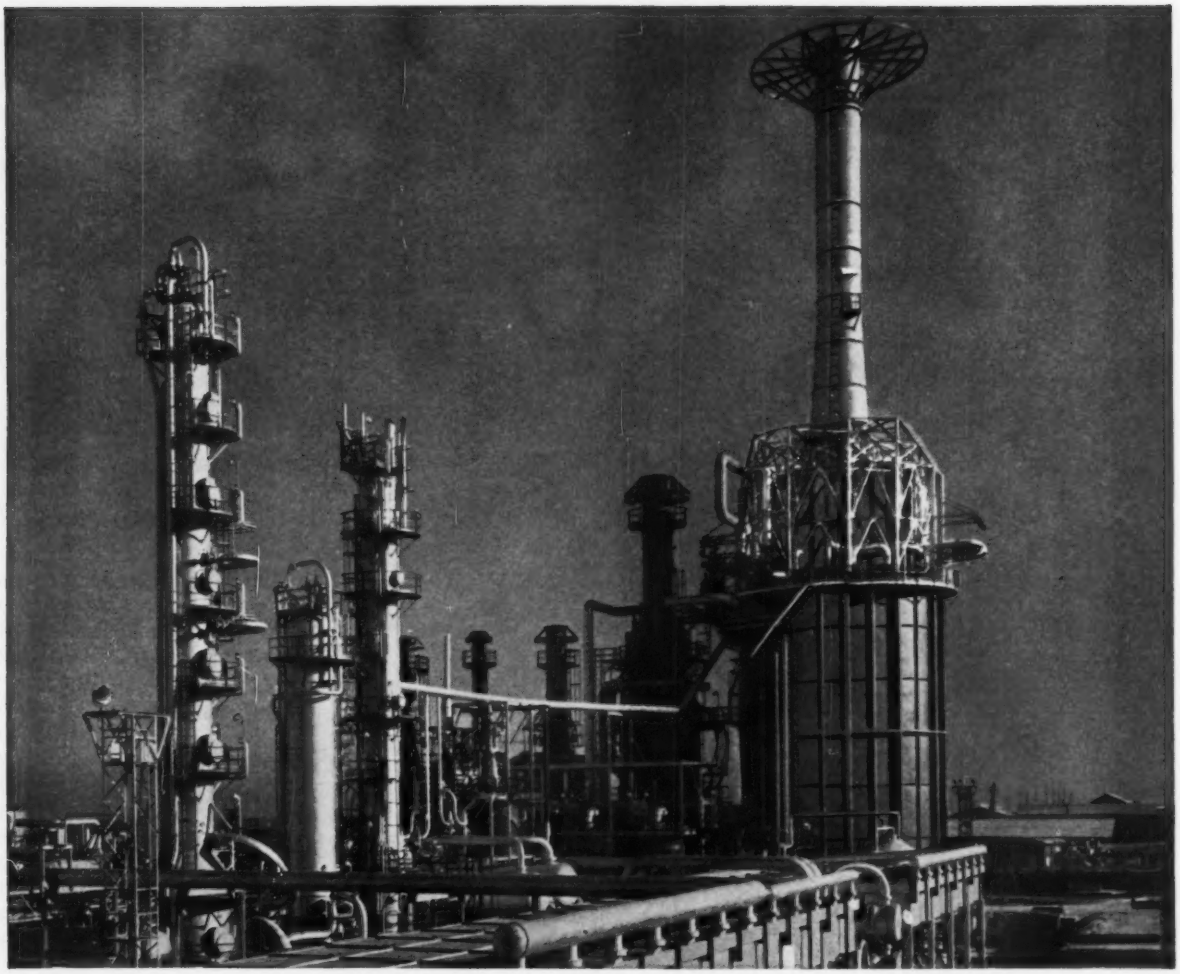

176 million Btu/hr from a single vertical heater

The Foster Wheeler direct-fired heater above is the largest cylindrical vertical heater in the world. It was designed and built for the Powerformer section of a major French refinery.

This unusual unit features a 41-foot diameter fire box and a separate horizontal convection section. It has an overall height of 200 feet and is designed for high thermal efficiency with ease of operation. Foster Wheeler coordinated U. S. engineering and foreign procurement to assure minimum cost.

Designing efficient direct-fired heaters ranging in size from giants like this one—to midget-sized 100,000 Btu/hr units for special applications—has been a continuing FW function for over 40 years. You will find FW's fired heater and process experience invaluable to the solution of your heating problems.

Consult with Foster Wheeler before you specify. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

FOSTER WHEELER

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PLASTIC PALL RINGS

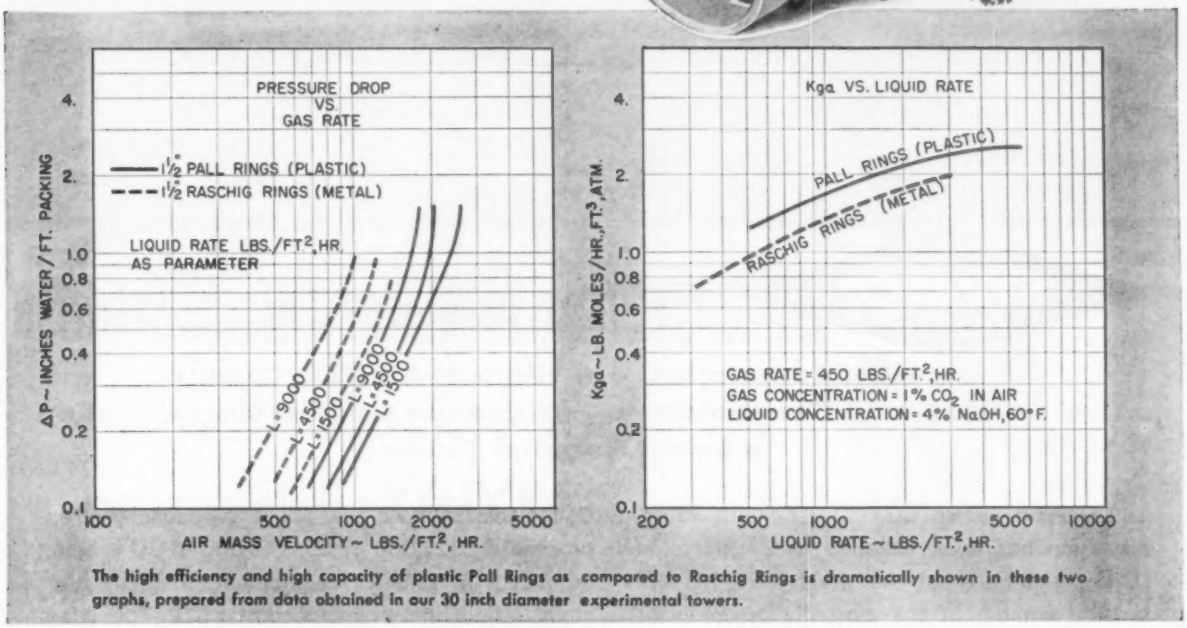
offer

high efficiency

high capacity

plus

extremely light weight


PRESSURE DROP VS. GAS RATE
1½" PALL RINGS (PLASTIC)
1½" RASCHIG RINGS (METAL)
LIQUID RATE LBS./FT.², HR. AS PARAMETER
L=9000
L=4500
L=1500
ΔP ~ INCHES WATER / FT. PACKING
AIR MASS VELOCITY ~ LBS./FT.², HR.
Kga VS. LIQUID RATE
PALL RINGS (PLASTIC)
RASCHIG RINGS (METAL)
GAS RATE = 450 LBS./FT.², HR.
GAS CONCENTRATION = 1% CO_2 IN AIR
LIQUID CONCENTRATION = 4% NaOH, 60°F.
Kga ~ LB. MOLES/HR., FT.³, ATM.
LIQUID RATE ~ LBS./FT.², HR.

The high efficiency and high capacity of plastic Pall Rings as compared to Raschig Rings is dramatically shown in these two graphs, prepared from data obtained in our 30 inch diameter experimental towers.

Weighing less than 5 lbs. per cu. ft. (as opposed to 23-27 lbs. per cubic foot in metal), plastic Pall Rings permit substantial economies in tower construction costs.

Plastic Pall Rings are injection molded in four sizes: ⅝", 1", 1½", and 2" in polypropylene (and on special order in rigid PVC or polystyrene). The sectioned wall projections, characteristic of the Pall Ring design, form a rigid cross-web in the ring for added structural strength.

Polypropylene possesses excellent resistance to strong alkalies, organic and inorganic acids including hydrofluoric acid and fluorine compounds at temperatures as high in some cases as 250°F.

ENGINEERING DATA

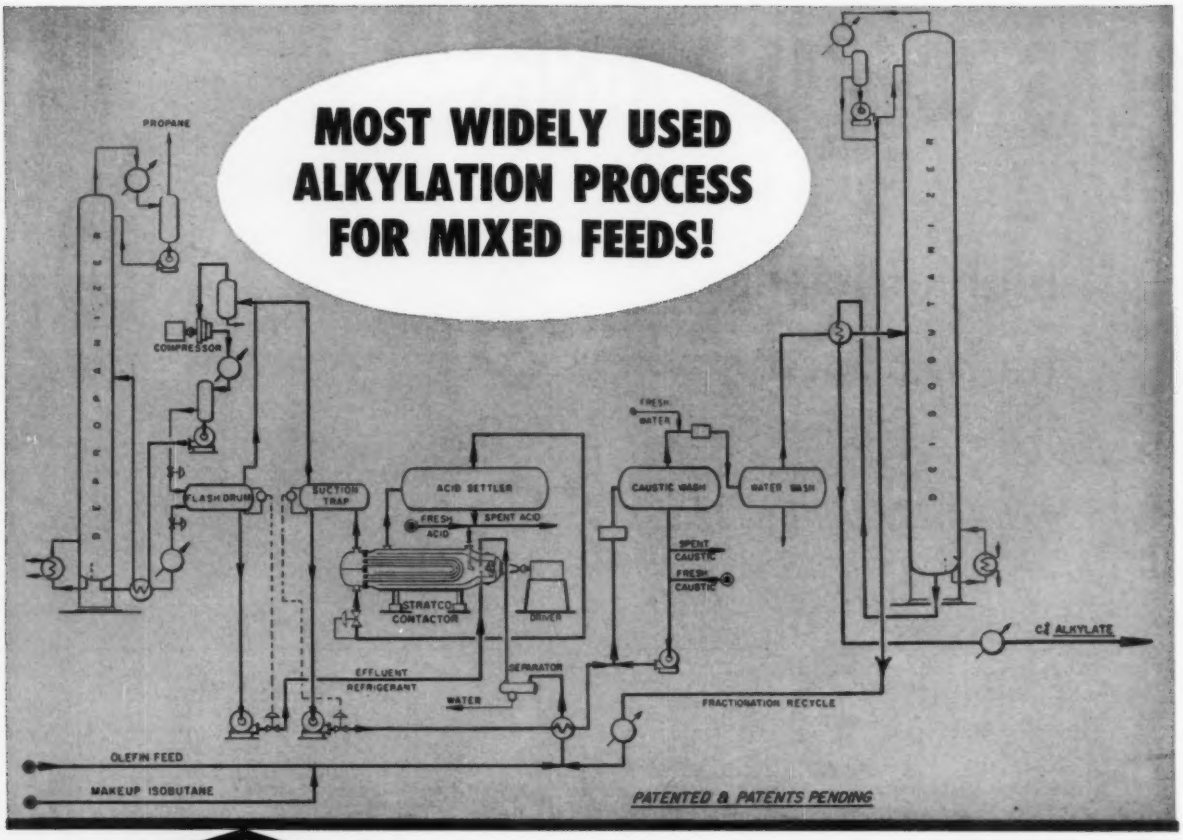
Are you on our mailing list to receive reports from our continuing engineering research program into packed tower performance? If not, a note on your letterhead will bring them promptly. Address Dept. ER., U. S. Stoneware, Akron 9, Ohio.

Process Equipment Division

U. S. STONEWARE

AKRON 9, OHIO

253-G



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EFFLUENT REFRIGERATION* ALKYLATION

- **Best Economics**
- **Highest Alkylate Quality**
- **Lowest Acid Consumption**
- **Easiest Mechanical Operation**
- **Least Reboiler Fouling**

Since 1955, STRATCO effluent refrigeration alkylation has been installed in 27 plants in refineries throughout the world. Included are a large number of the currently predominant mixed propylene-butylene operations.

Of the total sulfuric acid alkylation capacity of approximately 327,000 BPSD, 145,000 BPSD is being produced in STRATCO equipment. In study after study, refiners have concluded that STRATCO offers the best solution to alkylate production.

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STRATFORD ENGINEERING CORPORATION

• PETROLEUM REFINING ENGINEERS

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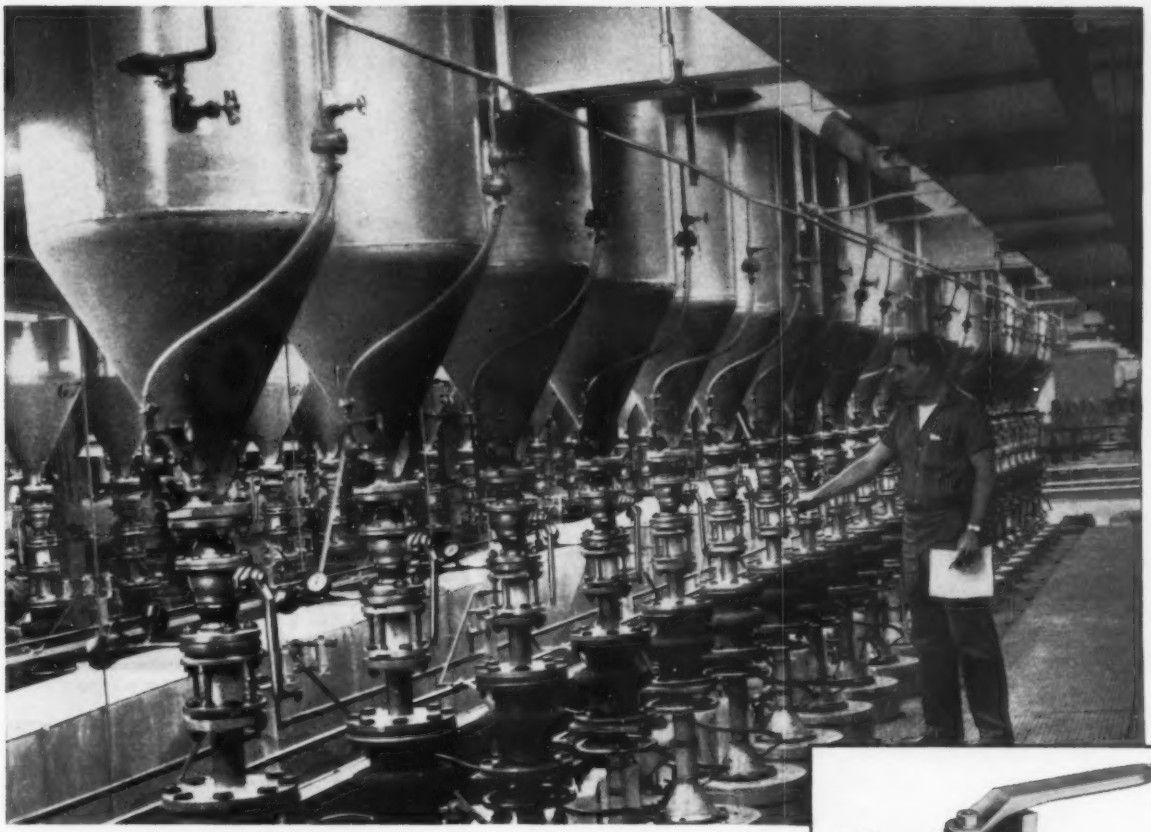
A560

They broke up the pellet traffic jam...



with Rockwood Ball Valves

A costly and recurrent problem in a large southern synthetic fibre mill was the jamming of polymer pellets as they came from supply hoppers. Source of the trouble was the tapered-throat design of the valves. Even with valves fully open, pellets piled up. In addition, this packing-in action caused severe abrasion on the valves. The problem was solved by replacement with Rockwood Ball Valves. Their *straight-through-opening* feature now permits pellet to flow smoothly . . . and the wear problem has been automatically eliminated because Rockwood valves offer no more resistance to flow than the pipeline itself.

What's more, after hundreds of openings and closings Rockwood Ball Valves still provide *positive leak-proof* shut-off means. A retainer spring, which *automatically compensates for pressure variations* keeps the seat snug against the ball and holds tight even under vacuum.

Thousands of Rockwood Ball Valves are giving efficient service and cutting costs throughout industry — in oil refineries, textile mills, paper, chemical and rubber plants.

There are types and sizes to meet every requirement in *your* plant. Write today for the illustrated folder on Rockwood Ball Valves. Tested and listed by Underwriters' Laboratories, Inc. Rockwood Sprinkler Division of the Gamewell Company. *A subsidiary of E. W. Bliss Company,* 223 Harlow St., Worcester 5, Mass. Distributors in principal industrial areas.

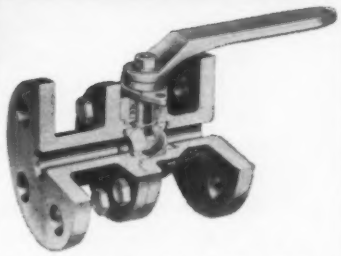


Fig. 254 Type 316 Stainless Steel

Rockwood Ball Valves are available in pipe sizes ⅜" through 16" in screwed ends 150 lb. and 300 lb. flanges. All internal parts are of Type 316 stainless steel with spring-compensated TEFLON* seats. Recommended for 600 p.s.i. working pressure and suitable for temperatures ranging from—100° F. to 400° F. All sizes are available with two retainer springs and two Teflon seats.

*DuPont Reg. T. M.

ROCKWOOD BALL VALVES

For more data on advertised products, use Readers' Service Cards, last page.

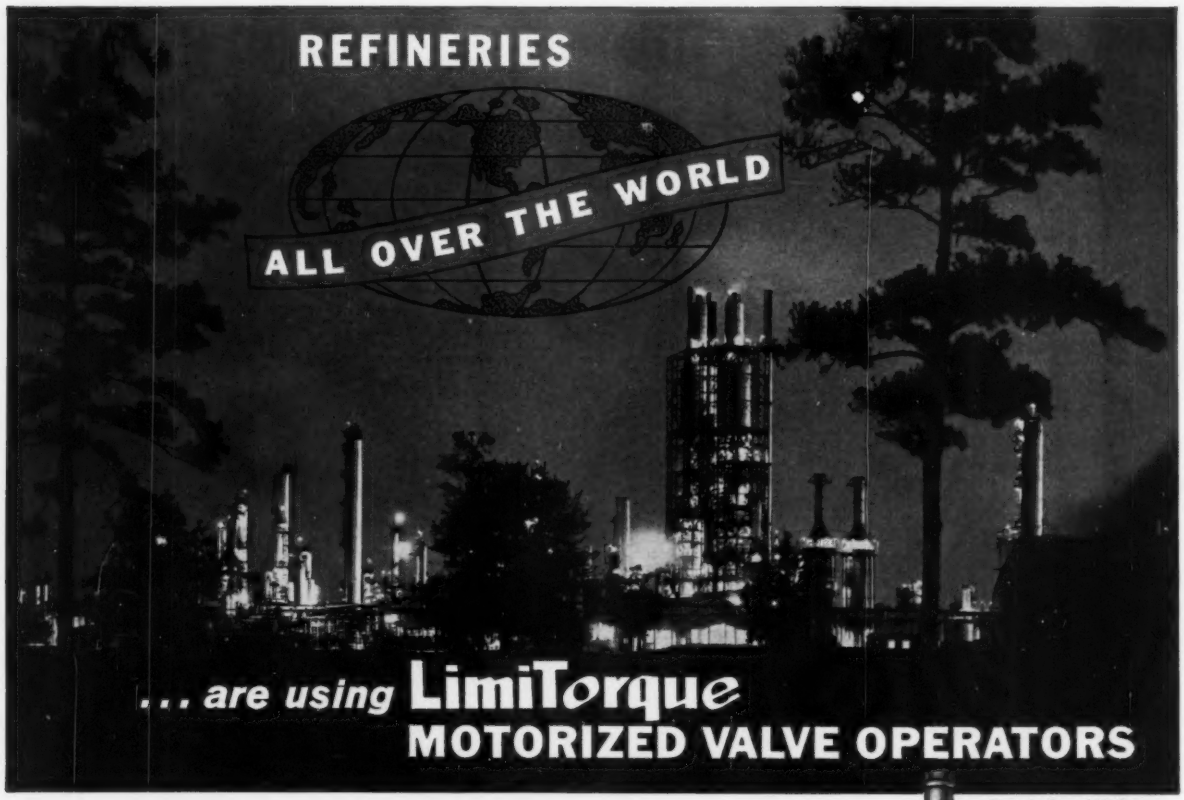
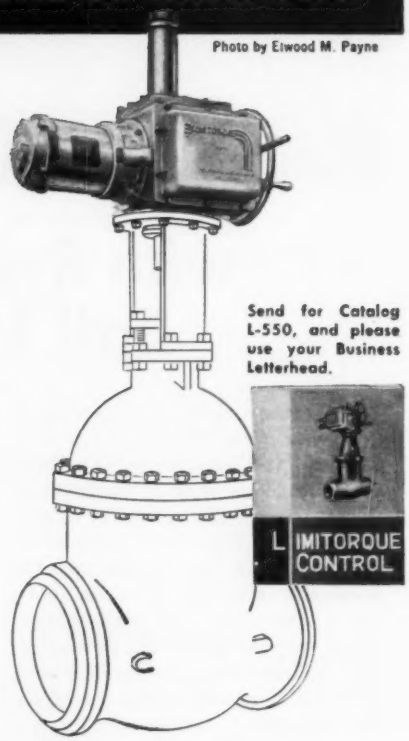


Photo by Elwood M. Payne

It is highly significant, that wherever there is a Modern Refinery, you will find vital valves operated day and night by LimiTorque Push-Button Motorized Controls . . . The reasons for such wide-spread use are many; first of course is their ABSOLUTE DEPENDABILITY under all pressure, temperature, and service conditions . . . Second, LimiTorque operators are ruggedly built, yet as accurate as a fine watch . . . And, because of a specially designed Torque Limiting Mechanism, they ELIMINATE ANY POSSIBILITY OF DAMAGE TO VALVE PARTS during the cycle of operation . . . also vitally important is the fact that they save TIME, LABOR AND MONEY . . . and, it should be kept in mind that LimiTorque is manufactured by one of the largest gear and geared products manufacturers in the World . . . it is the result of 28 years of experience.

For further information consult your valve manufacturer, or your nearest LimiTorque Sales-Engineering Office.



Send for Catalog L-550, and please use your Business Letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

½¢ Per Barrel Hydrotreating Catalyst

HARSHAW COBALT MOLYBDATE

Proven superiority where it counts—*long life* and *low cost*. Typical installations using Harshaw Cobalt Molybdate Catalyst and achieving catalyst costs of less than ½¢ per barrel:

a Hydrotreating cracked, high sulfur, high nitrogen stock: Catalyst retained high activity through over four years of service and 12 regenerations.

b Hydrotreating high sulfur straight run diesel oil: A first run of 2½ years without regeneration of the catalyst —and still going strong.

Active, rugged, and thermally stable, Harshaw Cobalt Molybdate Catalyst proves its superiority where it counts—with long life and resulting low cost. It can give you the type of performance cited above with any feedstock from low boiling naphthas to heavy vacuum distillates. In all applications, the long life of our catalyst reflects reduced per-barrel costs. For further information about this and other proven hydrotreating catalysts, contact the Harshaw branch nearest you.

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THE HARSHAW CHEMICAL CO.

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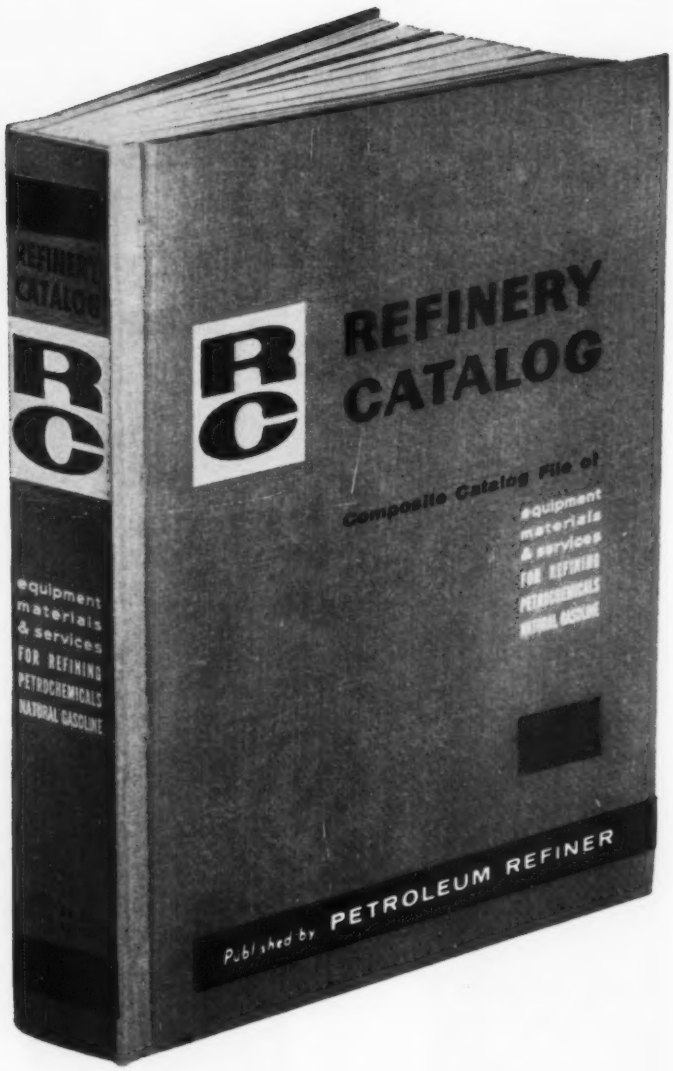

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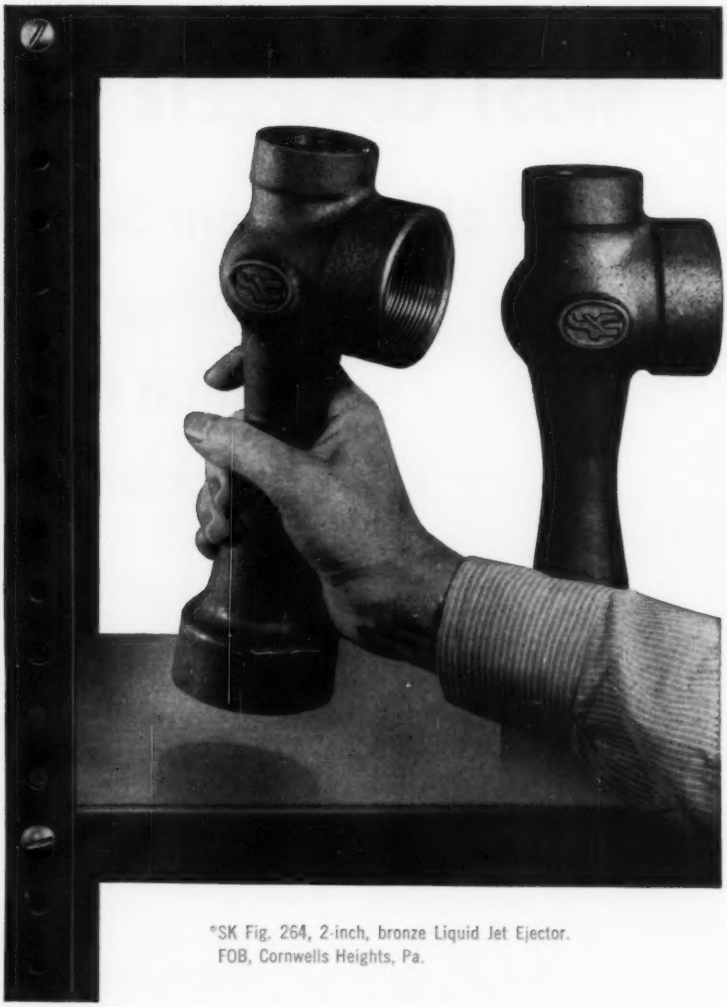
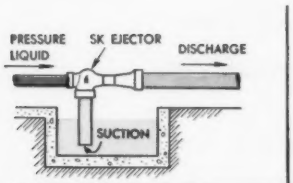
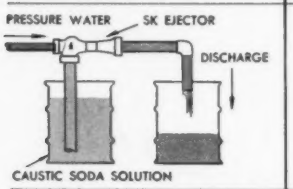
FOR $50.60 EACH* YOU CAN STOCK EJECTORS THAT WILL PUMP, MIX, EVACUATE, AGITATE



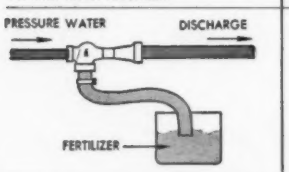
*SK Fig. 264, 2-inch, bronze Liquid Jet Ejector. FOB, Cornwells Heights, Pa.



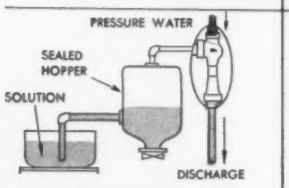
Pumping out a sump



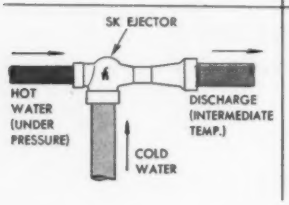
Diluting caustic



Handling slurry



Evacuating air (vacuum lift)



Heating cold water

Want to pump out a sump . . . mix two liquids, or a liquid and a solid . . . handle a slurry . . . prime a pump . . . agitate a solution? Low cost, uncomplicated SK Liquid Jet Ejectors are ideal for *any* of these jobs. That's why thousands of companies (like yours) keep several *always* in stock. Liquid Jet Ejectors utilize the kinetic energy of a pressure liquid to pump, mix and agitate other liquids, handle slurries and fine solids, and evacuate air. They are stocked in cast iron, bronze, 316 stainless steel, PVC, Haveg, and PYREX brand tubing, for quick delivery. The sketches will give you a few ideas on how you might use a stock ejector. For complete details on types, sizes, capacities, write for Bulletin 2M.

For immediate delivery, standard SK Jet Ejectors, Rotameters, and Flow Indicators are stocked in Cornwells Heights (Phila.), Pa., Houston, Texas, and San Francisco, Calif.

JET APPARATUS: Ask for Condensed Bulletin J-1.
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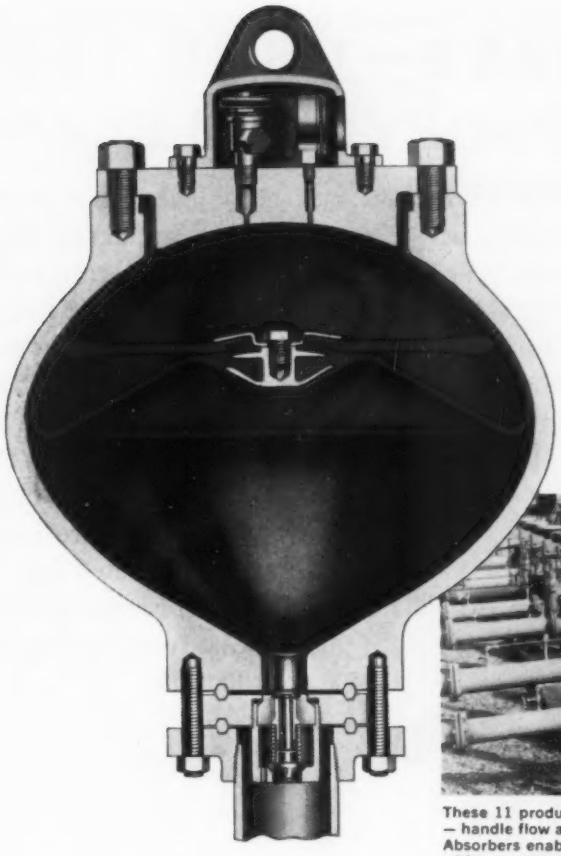
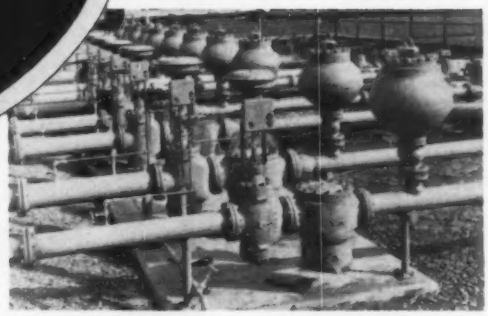
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Condensed Bulletin G-1.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.



prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!



These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

For more detailed information on Hydril Surge Absorbers, consult your Pipeline or Composite Catalog... or call your Hydril Representative

HYDRIL COMPANY

714 West Olympic Boulevard, Los Angeles 15, California

Factories: Los Angeles, Calif.; Houston, Texas

Sales offices: Bakersfield, Los Angeles, Ventura, California; Harvey, New Iberia, Louisiana; Oklahoma City, Tulsa, Oklahoma; Uniontor, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas; Casper, Wyoming; New York, New York; Calgary, Edmonton, Canada.

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KOCH FLEXITRAYS—USED 100%
IN LARGEST U. S. PROPYLENE PLANT

SUN OIL COMPANY'S $2,000,000 PROPYLENE PLANT – recently placed in successful operation at Sun's huge Marcus Hook, Pennsylvania, refinery – has a potential capacity of 120,000,000 pounds of high-purity propylene per year. Reputedly the largest operation of its kind in the United States, designed to produce the high-purity propylene required by manufacturers of polypropylene – Sun's new plant is currently producing a material with 99.9% purity from refinery gas streams. KOCH FLEXITRAYS HELP MAINTAIN THAT PURITY! Type "F" Koch Flexitrays–140 in all – were specified 100% in the two distillation towers that comprise the major equipment in the new plant. Considered the most dependable and economical device yet developed for distillation absorption and stripping, Koch Flexitrays often save refineries and chemical plants 20 to 40% on total cost of completed installations! For YOUR next tower – investigate Koch Flexitray before you specify! The extreme flexibility of this low-cost fractionating tray has led to its use in more than 1500 installations.

See our catalog in "Refinery Catalog" — or contact your nearest Koch representative.

Butte, Montana, G. M. Wallace & Co., P. O. Box 208
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Oakland, Calif., Engineered Process Equip. Co., 600 16th St.
Park Ridge, Illinois, M. B. Fisher, 1521 Courtland Ave.
Pasadena, Calif., Engineered Process Equip. Co., 774 E. Green St.
Pittsburgh 19, Penn., D. D. Foster Co., 2210 Koppers Bldg.
Salt Lake City, Utah, G. M. Wallace & Co., Continental Bank Bldg.
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European Fabrication Available!

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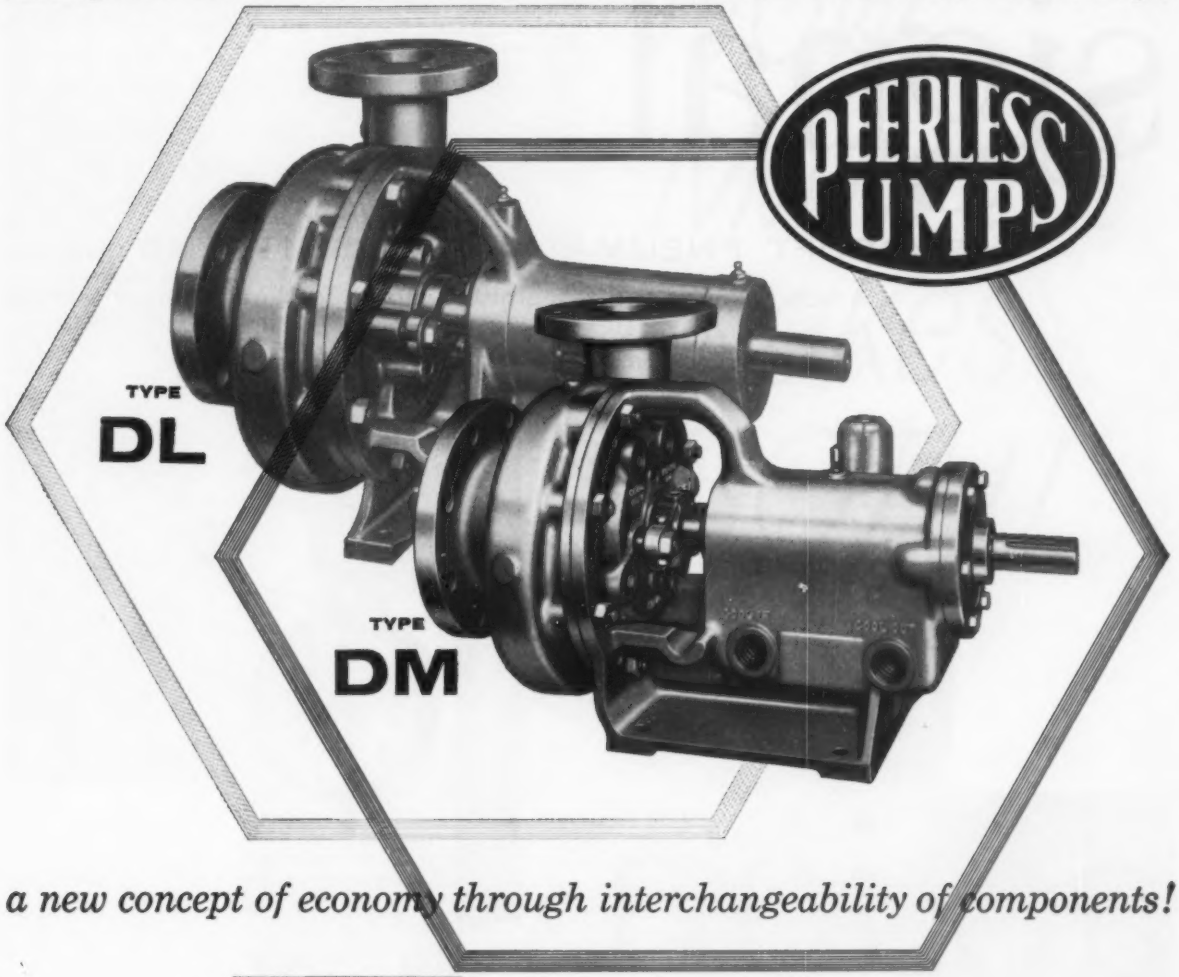
ENGINEERING COMPANY, INC.
321 West Douglas, Ave., Wichita 2, Kansas
"Pioneers of Better Trays"

Mr. Engineer: Cut Your Pump Inventory—Reduce Costs With These New, Proved Pumps



a new concept of economy through interchangeability of components!

PEERLESS PUMPS

INTEGRATED DESIGN

SUPERIOR DESIGN + TOP QUALITY CONSTRUCTION + MAXIMUM INTERCHANGEABILITY + OPTIMUM MATERIAL GROUPS AVAILABLE

= BROADEST HYDRAULIC COVERAGE WITH MINIMUM CUSTOMER INVENTORY OF PUMPS AND COMPONENTS

ACCESSIBILITY—Through ease of assembly and disassembly if and when required. **DURABILITY**—Through use of any machinable metal as materials of construction. **SERVICEABILITY**—Through designs that feature maximum ease of maintenance. **INTERCHANGEABILITY**—Through a choice of semi-open or enclosed impellers, oil or grease lubrication, air- or water-cooled back plates and bearing housings. **RELIABILITY**—Through the high performance standards set for these pumps, proving more than ever before, that Peerless Builds Dependable Pumps. **AVAILABILITY**—Shipment from stock of both complete pumps and pump components.

CAPACITIES: UP TO 1000 GPM • WORKING PRESSURE: UP TO 300 PSIG
HEAD RANGE: UP TO 430 FEET • TEMPERATURE RANGE: UP TO 450° F

Putting Ideas to Work

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump
HYDRODYNAMICS DIVISION

Offices:
New York; Detroit; Cleveland; Chicago; Indianapolis; St. Louis; San Francisco; Atlanta; Plainview; Lubbock; Phoenix; Albuquerque; Los Angeles; Fresno.

Distributors in principal cities. Consult your telephone directory.

Peerless Pump, Hydrodynamics Division, Food Machinery & Chem. Corp.
301 West Avenue 26, Los Angeles 31, California PR

Send me Bulletin B-1608 ☐ Have a field engineer contact me ☐

Company_____

Name_____ TITLE

Address_____

City_____ State_____

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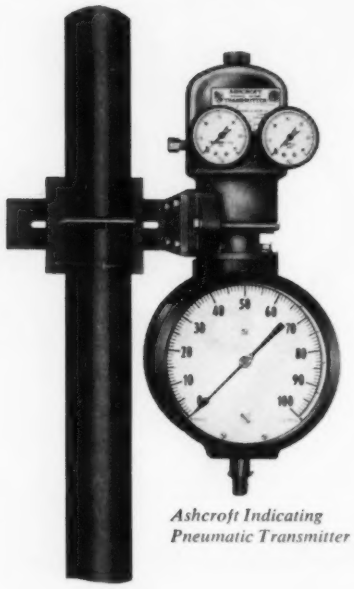
signal

ASHCROFT PNEUMATIC TRANSMITTERS give you a true primary and transmitted signal for indication or control



Ashcroft Indicating Pneumatic Transmitter

action

Now—detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters achieve these results for you at the lowest initial and operating costs.

Full-range, solid-front indicating and totally accessible nonindicating transmitters eliminate the need for costly high pressure lines, yet permit complete monitoring of process conditions in remote areas.

Narrow-span Ashcroft Transmitters are expressly designed with highest sensitivity and repeatability for the most accurate primary signal feed to controllers. You get better control and purer, lower-cost final products.

Only in Ashcroft Pneumatic Transmitters can you get the wide choice of Ashcroft Duragauge Bourdon tubes or American mercury or gas-actuated systems for sensing pressure or temperature conditions. You also get a time-proven, obstruction-proof, force-balance, nonbleed relay for economical, maintenance-free 3-15 psi or 3-27 psi signal transmission.

Write for factful Bulletins 360 and 361 or ask your nearby Ashcroft Distributor to help you select the right transmitters and receiver gauges for your specific requirements.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

ASHCROFT PNEUMATIC TRANSMITTERS

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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SEAMLESS

- Long radius or short—the finest ells ever made . . . hot coined for dimensional accuracy from end to end
- Forged at controlled heat for superior metallurgical quality
- Specially machined ends for quickest fit-up and welding
- Ells, tees, returns—all types of fittings—available in seamless through 24"
- Produced by newest, most modern equipment, combined with latest technology in forging, sizing, heat-treating and machining

Now... Midwest makes BOTH!

WELDED

- Formed from plate and welded—fully reinforced . . . same high quality as always
- Especially suited for Long Tangent bonus elbows, reducing ells, and special fittings of unusual shapes
- Stocked in carbon steel, wrot iron, chrome-moly . . . available in Hi-Yield and all other weldable metals
- Wall thicknesses up to 4"—or more
- Delivery from stock—with or without Long Tangents—in all sizes through 36"; to order, through 48"

The world's most complete line of welding fittings...for maximum flexibility in piping design

SOLD THROUGH STOCKING DISTRIBUTORS FROM COAST TO COAST

MIDWEST PIPING COMPANY, INC.
1450 SOUTH SECOND STREET
ST. LOUIS 4, MISSOURI

6004

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What makes **TRANSCOPE®**

Electronic and Pneumatic Recorders

the most wanted miniature instruments on the market today?

...*The answer is* **SERVO**

In the past 2 years thousands of Servomatic motors have proven the inherent advantages of this Taylor innovation. Heart of the 90J (pneumatic) and 700J (electronic) recorders, it puts TRANSCOPE Recorders in a class by themselves. It is the most reliable device yet developed for converting an input signal into an accurate record. The tremendous power of these Servomatic motors—150 times greater than the bellows type (pneumatic), over 1,000 times greater than galvanometer systems (electronic)—gives you all these advantages:

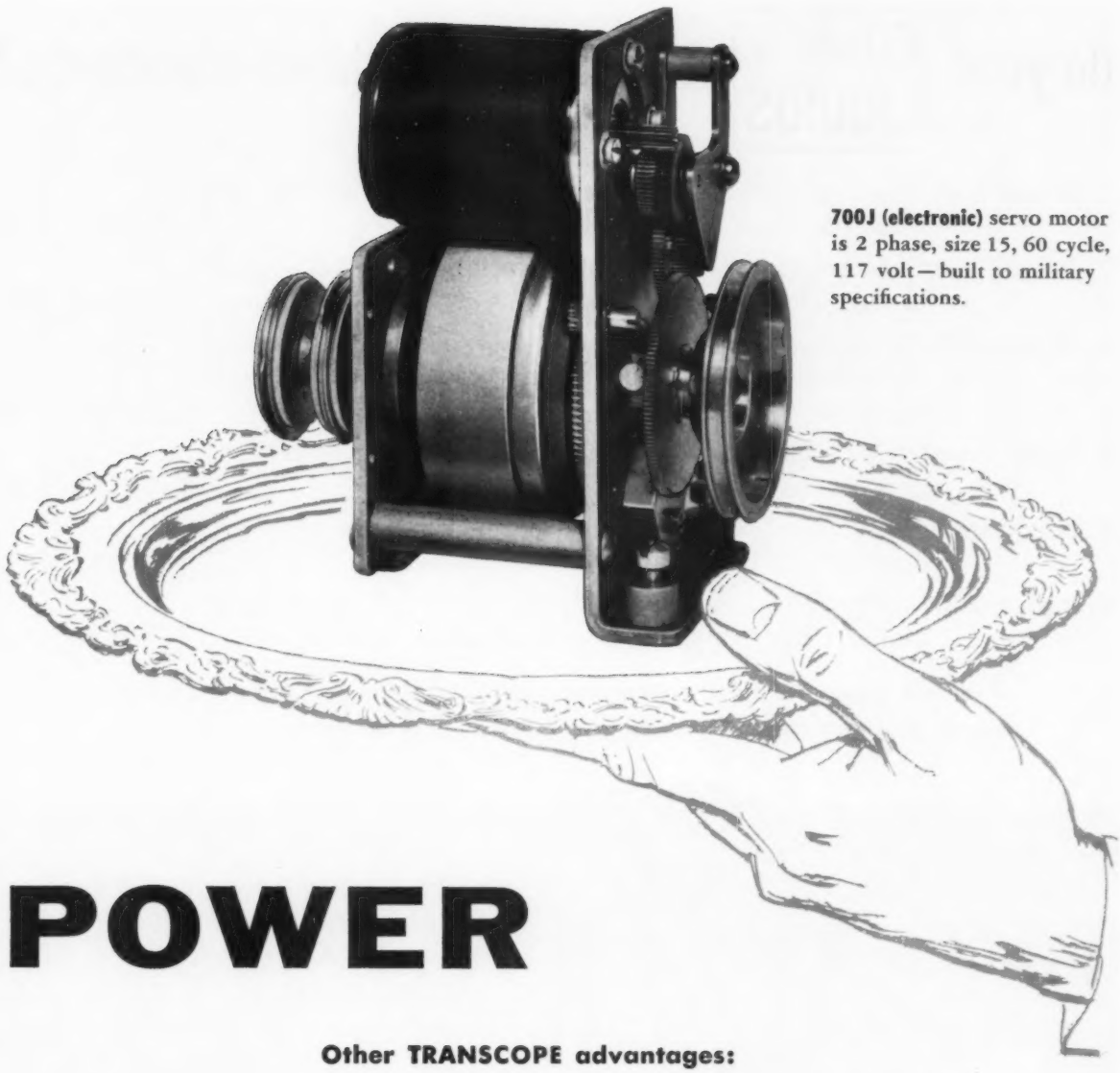
- Greater accuracy than ever before—½ of 1% in standard instruments, ¼ of 1% optional.
- Threshold sensitivity of 0.1% to input signal.
- 3 months' ink supply mounted on the pen—no troublesome capillary.
- Lifetime recording accuracy—no critical pen pressure.
- No flimsy linkages and levers.
- Truly rectilinear chart—no curved time lines.

Plus these optional features: alarm contacts—retransmitting potentiometer—function generation—digital output with encoder discs.

* * *

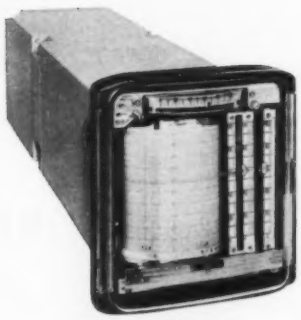
Ask your Taylor Field Engineer for full details of all the many superior features of TRANSCOPE servo-operated recorders. Or write for Bulletin 98286 (pneumatic) or 98335 (electronic). Taylor Instrument Companies, Rochester, New York, or Toronto, Ontario.

See it demonstrated at the ISA Show, Booths 1432-36; 1531-35



700J (electronic) servo motor is 2 phase, size 15, 60 cycle, 117 volt—built to military specifications.

POWER



Other TRANSCOPE advantages:

- Unconfused readability—because chart record, pen and set-point are side-by-side.
- 4″ chart reads from left to right—on rectilinear coordinates.
- Controller response adjustments may be made from the front—you can watch the results.
- Separate Plug-in Set Point Transmitters permit staying on automatic control—even when recorder slide is removed.
- All principal assemblies are plug-in mounted for flexibility and accessibility.
- Plug-in recorders and controllers permit housings to be shipped 4-6 weeks earlier than completed instruments to enable you to make all necessary connections to tagged manifolds.

Recorders of the future will have SERVO POWER . . . TAYLOR has it NOW!

Taylor Instruments **MEAN ACCURACY FIRST**

do your FOAM LIQUIDS measure up to these standards?

1. Is your foam liquid listed under the Underwriters' Laboratories' Reexamination Service? ☐ Yes ☐ No
2. Is every batch of foam liquid fire tested at the factory before it is shipped to you? ☐ Yes ☐ No
3. Does your foam liquid have a good record of stability over years of storage, and is it free from sediment that might foul the action of your equipment? ☐ Yes ☐ No
4. Is your foam liquid supplier able to make fast emergency shipments at any time of day or night? ☐ Yes ☐ No
5. Does your foam liquid supplier maintain active foam liquid research, development, and technical service programs? ☐ Yes ☐ No
6. If your foam liquid may be used below 10°F, is it a true "Cold Foam" liquid that will proportion properly at temperatures down to —20°F? ☐ Yes ☐ No

If you can answer YES to all six questions, you're already using National Aer-O-Foam Liquids. If not, you need them! For full information, write for Booklet B

Carried into the field untrained and too young. Not much fun for anybody! Just like the fabricating and installing of critical piping, wherein all-around complete satisfaction depends on specialized experience. So, direct your next high-pressure, high-temperature job *only* to specialists. Ask us in.

W. K. MITCHELL & CO., INC.

Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

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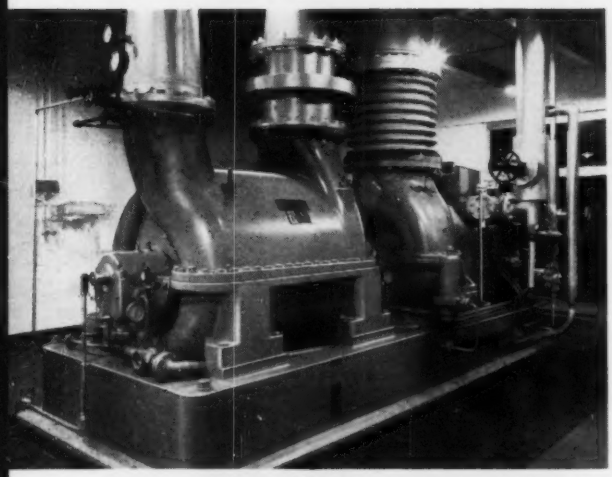
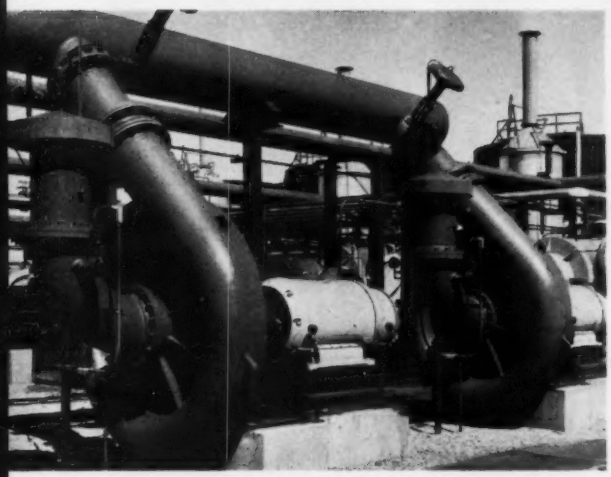
in Chemical and Petroleum Refining Service–

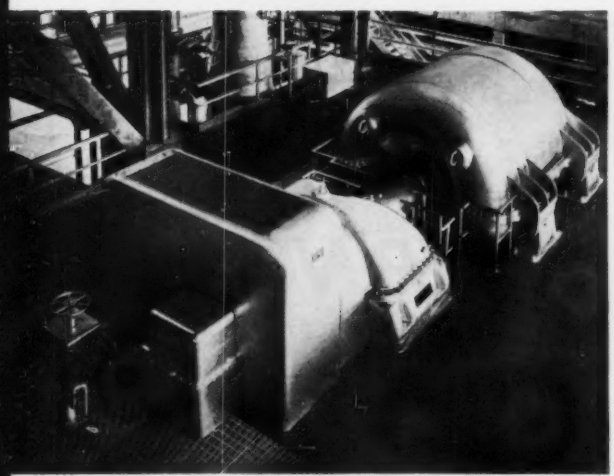
ELLIOTT



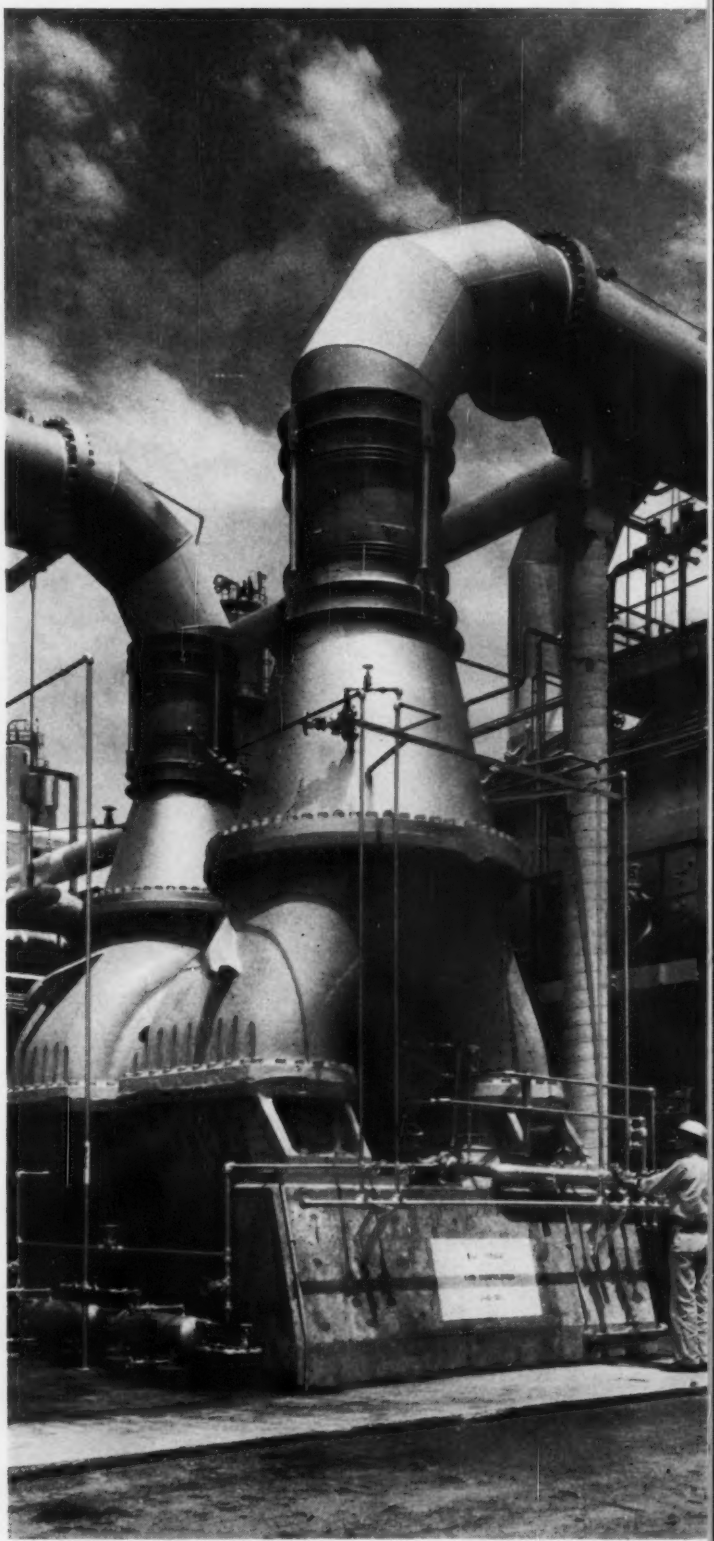
Elliott multi-stage compressor with 2035-hp Elliott turbine drive, in refinery service.



Two single-stage Elliott compressors driven by Elliott motors.



One of the largest turbine-driven multi-stage compressors ever installed, for fluid catalytic cracking unit.



One of the large axials serving a Petro-Chemical plant.

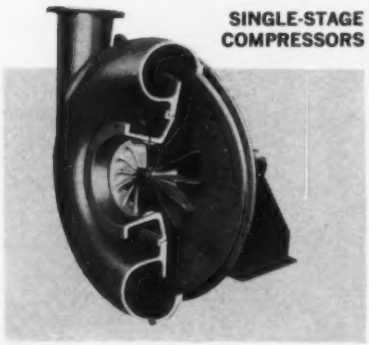
COMPRESSORS

Today's most complete line of centrifugal and axial machines from **500** *cfm to* **600,000** *cfm*

48 FRAME SIZES WITH MATCHING DRIVERS

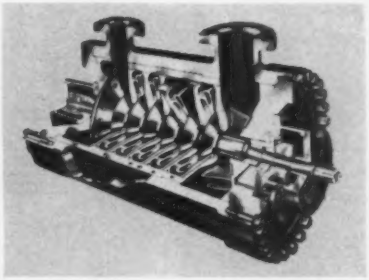
With this, the most-complete line of centrifugal and axial compressors available today—Elliott offers an unexcelled range of choice of established machines. In addition, there is the extra advantage of matching Elliott turbine or motor drivers. Both units engineered and built by Elliott is a decided "plus" because it means unified responsibility, unified service.

SINGLE-STAGE COMPRESSORS



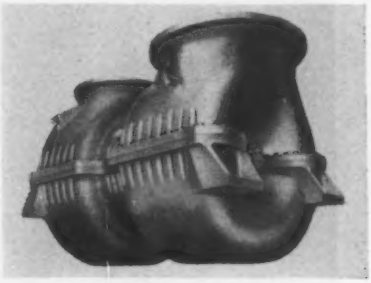
Elliott single-stage centrifugal compressors range in size from 700 to 100,000 icfm and above. They are readily adaptable to special service conditions, and to the handling of corrosive or dirty gases. A variety of impeller designs, bearings, seals, and materials of construction permits each unit to be tailored to its particular application.

MULTI-STAGE CENTRIFUGAL COMPRESSORS



Elliott multi-stage compressors are made in a wide variety of sizes and styles, to serve many difficult and exacting applications. They are available with inlet capacities up to approximately 150,000 icfm. Impellers, casings, internal passages and bearings for each type of machine have been designed to provide smoothly operating, rugged, dependable machines.

AXIAL FLOW COMPRESSORS



Multi-stage compressors of the axial flow type are designed and engineered specifically to serve the needs of industry for the handling of air or gas mixtures in large volume flow operation. Applications include petroleum refining, chemical processing and the steel industry. Frame sizes are rated up to approximately 600,000 cubic feet per minute when operating on air.

MATCHED MOTOR OR TURBINE DRIVE

Elliott is a leading manufacturer of both steam turbines and electric motors, of all types and ratings necessary to provide driving power for the compressor units described above. Consequently, we are in position to recommend and furnish the type of drive best suited for each application.

FOR AIR OR GASES

Elliott integrated compressor units are available for handling all types of compressible fluids, within the pressure and flow limits of the machines. Where corrosive gases are handled, special materials are employed in vulnerable spots; where high pressures are needed, extra heavy construction is used; where leakage must be prevented, special shaft seals are available; where high temperatures must be avoided, provision is made for cooling.

48 STANDARD FRAME SIZES

The total of 48 frame sizes permits accurate application for all compressor problems over the entire range of 500 cfm to 600,000 cfm. Pressures and speeds can be selected to meet the characteristics of the application, and the gas to be handled. *For further information, write Compressor Department, Jeannette, Penna.*

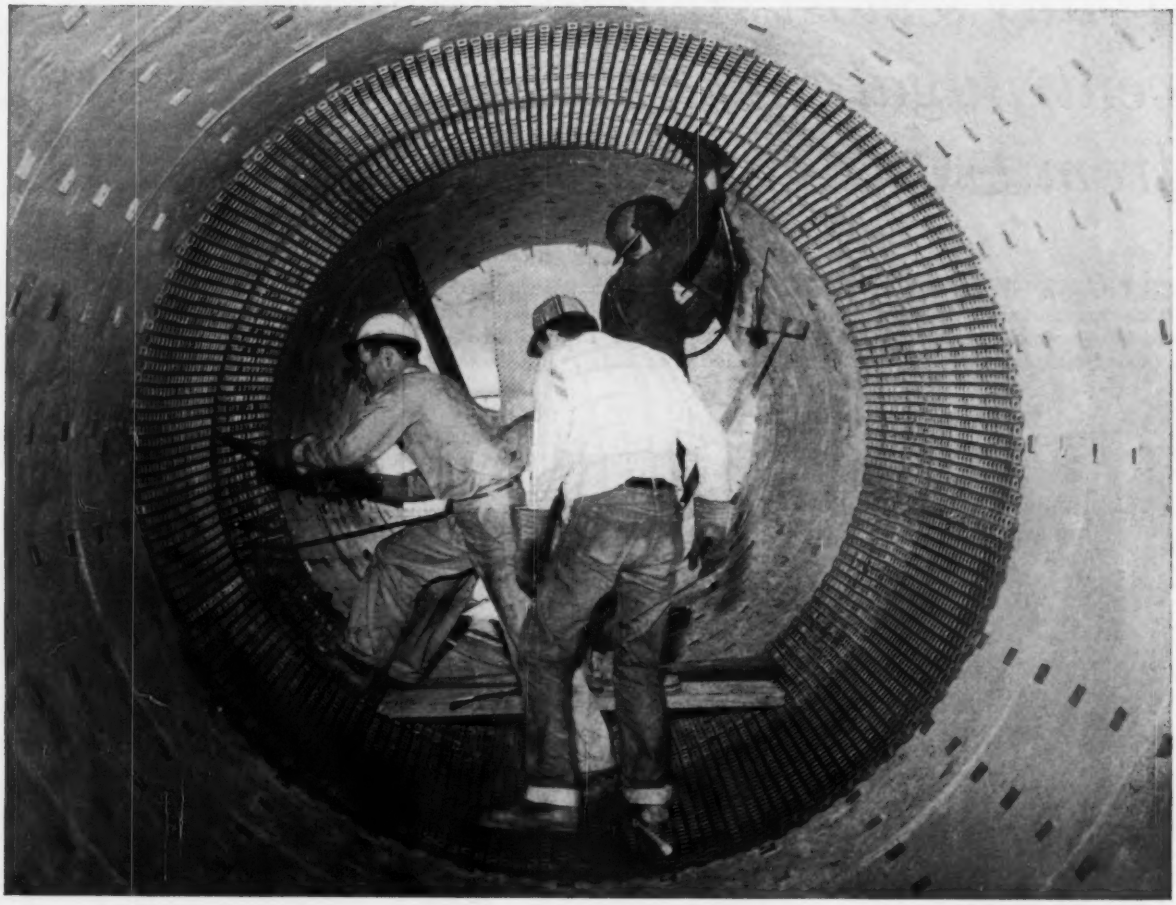
ELLIOTT THE MOST COMPLETE LINE OF **INTEGRATED COMPRESSOR & DRIVER UNITS** 500 cfm to 600,000 cfm

ELLIOTT Company
Jeannette, Penna.

PO-1

sors ever installed, for fluid catalytic cracking unit.

Refractory insulating concrete protects catalyst lines against erosion



Gunite Contractor: J. A. McCollum, Inc., Marlton, N. J. Castables: Kaiser Refractories & Chemicals Div.

In this catalyst line at a large Gulf Coast refinery, steel mesh is being welded into place over a 3-inch lining of refractory insulating concrete made with LUMNITE calcium-aluminate cement. Over the mesh, a 1-inch thickness of high-strength castable will be gunited, providing a 2-component refractory concrete lining that will resist severe erosion and abrasion caused by catalyst fines. Monolithic refractory concrete linings eliminate troublesome mortar joints. They are easily placed, conforming to any contour. Castables are recommended because they are simply mixed with water and placed – concrete reaches service strength in 24 hours. Castables containing LUMNITE cement are available from leading manufacturers of refractories for a variety of applications in refinery equipment. For information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas" and "Lumnite" are registered trademarks.

Universal Atlas Cement
Division of
United States Steel

L-198

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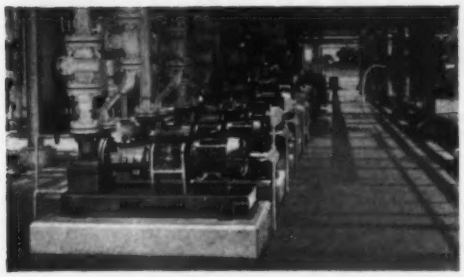
Quality *costs less* in the long run!

BJ Process Pumps

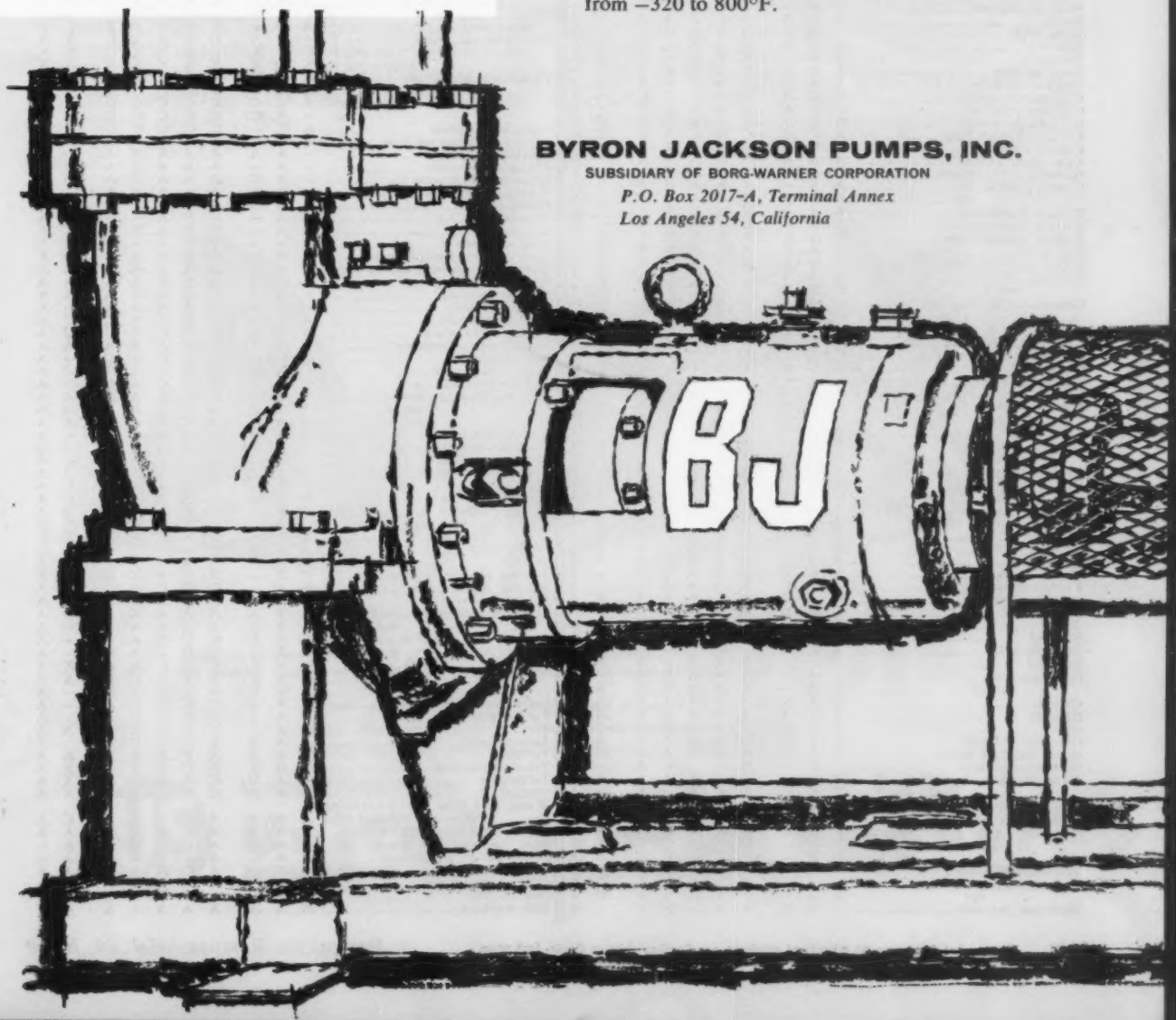
The ability to keep on stream is the real test of a process pump. Under continuous operation with corrosive or toxic fluids, extreme temperatures and other rugged conditions, it's the quality pump that pays off with long, dependable service.

Byron Jackson's quality comes from sound basic design, careful construction, and the backing of a quality manufacturer. BJ's complete line of process pumps puts the right pump on your job – and BJ's quality keeps it there!

Single and double stage models available . . . capacities to 5,000 GPM, heads to 1,900 feet, temperatures from –320 to 800°F.



Continental Oil Company uses both SM and SMI model BJ Process Pumps in this Oklahoma field processing plant.



BYRON JACKSON PUMPS, INC.
SUBSIDIARY OF BORG-WARNER CORPORATION
P.O. Box 2017-A, Terminal Annex
Los Angeles 54, California

Resistance Ratings
A = Good
F = Fair
C = Depends on conditions
X = Unsuitable

CAUTION: Do not use table without reading text.

	Asbestos			All Rubber					Misc.	
	Compressed sheet	Woven rubber	Woven neoprene	GR-S	Neoprene	Buna-N	Butyl	Natural	Plant-fiber sheet	Teflon
Acetic acid, crude	C	C	A	C	F	F	F	C	F	A
pure	C	C	A	C	F	F	F	C	F	A
vapors	C	C	A	C	F	F	F	C	F	A
150 p.s.i., 400 deg. F.	F	C	–	X	F	F	X	X	X	A
Acetic anhydride	–	C	A	–	–	–	–	–	–	A
Acetone	A	A	X	A	C	X	A	F	C	A
Acetylene	A	A	–	A	C	A	A	A	C	A
Air	A	A	A	A	A	A	A	A	A	A
Aluminum chloride	A	A	A	A	A	A	A	–	–	A
Aluminum fluoride	–	A	–	–	–	–	–	–	–	A
Aluminum sulphate	–	A	A	A	A	A	A	A	–	A
Alums	A	A	C	A	A	A	A	A	–	A
Ammonia gas, cold	A	A	A	A	A	A	A	A	A	A
hot	A	A	–	C	A	C	C	A	C	A
Ammonium chloride	A	C	A	–	A	–	A	C	X	A
Ammonium hydroxide	A	A	A	C	A	C	A	C	F	A
Ammonium nitrate	–	C	F	A	A	A	A	A	–	A
Ammonium phosphate, monobasic	–	C	A	A	A	A	A	A	–	A
dibasic	–	A	A	A	A	A	A	A	–	A
tribasic	–	A	A	A	A	A	A	A	–	A
Ammonium sulphate	A	C	A	A	A	A	A	A	–	A
Amyl acetate	A	A	C	X	X	X	–	F	C	A
Amyl alcohol	A	A	C	A	A	A	A	A	A	A
Aniline, aniline oil	A	A	–	X	F	F	X	A	F	A
Aniline dyes	A	A	–	F	F	F	A	F	–	A
Asphalt	F	A	–	X	F	F	A	X	F	A
Barium chloride	A	C	A	A	A	A	A	A	–	A
Barium hydroxide	A	A	A	A	A	A	A	A	F	A
Barium sulphide	–	A	–	A	A	A	A	A	–	A
Beer	A	A	X	A	A	X	A	A	A	A
Beet sugar liquors	A	A	A	A	A	A	A	A	A	A
Benzene, benzol	C	A	X	X	X	X	X	X	A	A
Benzine, petroleum ether, naphtha	C	A	X	X	X	X	X	X	A	A
Black sulphate liquor	A	A	–	X	A	A	A	A	X	A
Blast furnace gas	C	A	–	C	C	C	C	C	X	A
Borax	A	A	A	A	A	C	F	A	A	A
Boric acid	–	A	A	A	A	A	A	A	–	A
Bromine	X	X	X	X	X	X	X	X	X	A
Butane	A	A	–	X	F	C	–	X	X	A
Butyl acetate	A	A	X	X	X	A	F	F	C	A
Butyl alcohol, butanol	A	A	C	A	A	A	A	A	X	A
Calcium bisulphite	C	C	A	A	C	–	–	C	C	–	A
Calcium chloride	A	C	A	A	A	A	A	C	A	A
Calcium hydroxide	A	A	A	A	C	A	A	A	A	F	A
Calcium hypochlorite	A	C	A	A	C	A	A	A	C	F	A
Caliche liquors	–	C	–	–	A	A	A	A	–	F	A
Cane sugar liquors	A	A	A	A	A	A	A	A	A	F	A
Carbolic acid, phenol	–	A	C	X	C	X	X	X	–	A	A
Carbon dioxide, dry	A	A	–	A	A	A	A	A	X	A	A
wet	A	A	–	A	A	A	A	A	X	A	A
Carbon bisulphide	A	A	–	X	X	X	X	X	X	A	A
Carbon monoxide, hot	A	A	–	A	C	C	C	C	C	A	A
Carbon tetrachloride	F	A	X	X	X	X	X	X	C	A	A
Castor oil	A	A	X	A	A	A	A	A	C	A	A
China wood oil, tung oil	A	A	X	X	F	A	–	X	C	X	A
Chlorine, dry	F	A	X	F	F	F	F	A	X	A	A
wet	F	X	X	F	F	F	F	F	X	A	A
Chlorinated solvents, dry	C	A	X	X	X	C	X	X	X	A	A
wet	C	A	X	X	X	C	X	X	X	A	A
Chloroacetic acid	–	X	X	–	–	–	–	–	–	–	A
Chlorosulphonic acid	C	X	X	X	X	X	X	X	X	C	A
Chromic acid	C	X	X	X	X	X	C	X	C	X	A
Citric acid	C	C	A	F	C	A	F	C	A	F	A
Coke oven gas	A	A	–	C	A	C	C	C	X	A	A
Copper chloride	A	C	A	A	A	F	A	F	A	–	A
Copper sulphate	A	C	A	A	A	A	F	A	A	A	A
Corn oil	A	A	X	X	X	F	A	A	X	C	A
Cotton seed oil	A	A	X	X	X	F	A	A	X	X	A
Creosote, coal tar	A	A	–	X	X	F	A	X	X	X	A
wood	C	A	X	X	X	F	A	X	X	X	A
Cresols, cresylic acid	–	A	X	X	X	X	F	X	X	–	A
Dowtherm, A	C	A	X	X	X	C	C	F	X	X	A
E	C	A	X	X	X	C	C	F	X	X	A
Ethers	A	A	X	X	X	C	C	F	C	F	A
Ethyl acetate	A	A	X	C	F	X	X	F	F	X	A
Ethyl cellulose	F	A	–	F	F	F	F	F	F	X	A
Ethyl chloride	A	A	–	F	A	F	A	A	A	C	A
Ethylene glycol	A	A	–	A	A	A	A	A	A	A	A
Ferric chloride	–	C	C	A	A	A	A	A	A	–	A
Ferric sulphate	–	C	C	A	A	A	A	A	A	–	A
Formaldehyde	C	A	C	A	C	X	A	A	A	F	A
Formic acid	–	X	C	A	X	X	A	A	A	–	A
Freon	C	A	–	X	F	A	F	X	X	C	A
Fuel oil	A	A	–	X	F	A	X	X	X	X	A
Fuel oil, acid	–	A	–	–	–	–	–	–	–	–	A
Furfural	C	A	–	X	X	X	–	X	X	X	A
Gasolene, sour	–	A	–	X	A	A	X	X	–	–	A
refined	C	A	–	X	A	A	X	X	X	X	A
Gelatin	A	A	A	A	A	A	A	A	A	A	A
Glucose	A	A	A	A	A	A	A	A	A	A	A
Glue	A	A	A	F	A	A	F	F	C	A	A
Glycerin, glycerol	A	A	C	A	A	A	A	A	A	A	A
Green Sulphate liquor	A	A	–	A	A	A	A	A	X	A	A
Hydrobromic acid	–	C	–	X	–	–	–	A	–	–	A
Hydrochloric acid, <150 deg. F.	F	C	C	A	F	F	A	A	–	–	A
>150 deg. F.	X	C	C	X	F	X	–	F	–	–	A
Hydrocyanic acid	–	A	–	–	–	–	–	–	–	–	A
Hydrofluoric acid, cold, <65%	X	X	–	F	A	–	F	F	X	A	A
>65%	X	X	–	X	X	X	C	X	X	A	A
hot, <65%	X	X	–	C	A	–	C	C	X	A	A
>65%	X	X	–	X	C	–	C	A	X	A	A
Hydrofluosilicic acid	A	X	–	A	F	A	A	A	X	A	A
Hydrogen gas, cold	A	A	–	F	A	A	A	F	C	A	A
hot	A	A	–	F	A	A	A	F	C	A	A
Hydrogen peroxide	–	A	X	F	A	–	F	F	–	A	A
Hydrogen sulphide, dry, cold	–	A	X	C	F	C	A	C	–	A	A
hot	–	A	X	C	C	C	A	C	–	A	A
wet, cold	–	A	X	C	F	C	A	C	–	A	A
hot	–	A	X	C	F	C	A	C	–	A	A
Kerosene	A	A	X	C	F	F	A	C	C	A	A
Lacquers	C	A	X	X	X	X	X	X	X	X	A
Lacquer solvents	C	A	X	X	X	X	X	X	X	X	A
Lactic acid, cold	A	A	A	C	C	C	C	C	C	C	A
hot	A	C	A	C	C	C	C	C	C	C	A
Linseed oil	A	A	C	C	F	A	A	C	C	A	A
Lubricating oils, sour	A	A	C	C	F	A	A	X	F	A	A
refined	A	A	C	C	F	A	A	X	F	A	A
Magnesium chloride	A	C	C	C	A	A	A	A	A	C	A
Magnesium hydroxide	A	C	C	C	A	A	A	A	A	C	A
Magnesium sulphate	–	C	C	C	A	A	A	A	A	–	A
Mercuric chloride	–	C	C	C	–	–	–	–	–	–	A
Mercury	C	A	–	–	–	–	–	–	–	–	A
Methyl alcohol, methanol	A	A	C	A	A	A	A	A	A	C	A
Methyl chloride	C	A	–	C	A	C	A	C	C	–	A
Milk	–	A	X	C	A	F	A	X	C	–	A
Mineral oils	A	A	X	C	F	A	A	X	C	C	A
Natural gas	A	A	–	C	F	A	A	X	F	–	A
Nickel chloride	–	C	A	A	A	A	A	A	A	–	A
Nickel sulphate	–	C	A	A	A	A	A	A	A	–	A
Nitric acid, crude	C	X	X	X	X	X	X	C	X	–	A
diluted	C	X	X	X	X	X	X	C	X	–	A
concentrated	X	X	X	X	X	X	X	C	X	–	A
Nitrobenzene	–	C	–	X	X	X	C	X	X	–	A
Oleic acid	A	A	–	F	A	A	–	F	–	–	A
Oleum spirits	–	X	X	–	–	–	–	–	–	–	A
Oxalic acid	A	X	A	F	–	–	–	F	C	A	A
Oxygen, cold	A	A	–	C	A	C	C	–	C	C	A
<500 deg. F.	C	A	–	C	C	C	C	–	C	X	A
500–1,000 deg. F.	–	A	–	–	–	–	–	–	X	–	X
>1,000 deg. F.	X	X	–	X	X	X	X	X	X	X	X
Ozone	–	–	–	–	–	–	–	–	–	–	–
Palmitic acid	A	A	–	F	A	A	A	F	C	A	A
Petroleum oils, crude, <500 deg. F.	A	A	X	C	A	A	X	C	X	A	A
>500 deg. F.	C	A	X	X	X	X	X	C	X	X	X
>1,000 deg. F.	X	C	X	X	X	X	X	C	X	X	X
Phosphoric acid, crude	A	X	C	C	C	C	C	C	C	–	A
pure, <45%	A	X	C	C	C	C	C	C	C	–	A
>45%, cold	A	X	C	C	C	C	C	C	C	–	A
hot	–	X	C	C	C	C	C	C	C	–	A
Picric acid, molten	A	C	–	C	A	A	A	C	C	C	A
water solution	A	X	C	C	A	A	A	A	A	A	A
Potassium chloride	–	A	A	A	A	A	A	A	A	–	A
Potassium cyanide	–	A	–	A	A	A	A	A	A	–	A
Potassium hydroxide	–	A	C	A	A	A	A	A	A	–	A
Potassium sulphate	–	A	A	A	A	A	A	A	A	–	A
Producer gas	A	A	–	–	–	–	–	–	–	–	A
Propane	A	A	–	–	F	A	–	–	–	–	A
Sewage	A	A	–	C	F	A	X	C	C	C	A
Soap solutions	C	A	A	C	F	A	–	C	C	A	A
Soda ash, sodium carbonate	A	A	A	A	A	A	A	A	A	A	A
Sodium bicarbonate, baking soda	A	A	A	A	A	A	A	A	A	A	A
Sodium bisulphate	A	C	A	A	A	A	A	A	A	A	A
Sodium chloride	A	A	A	A	A	A	A	A	A	A	A
Sodium cyanide	–	A	–	A	A	A	A	A	–	A	A
Sodium hydroxide	A	A	A	C	C	C	C	C	C	A	A
Sodium hypochlorite	A	C	A	A	C	C	C	A	C	A	A
Sodium metaphosphate	A	C	A	A	C	C	C	A	C	A	A
Sodium nitrate	A	C	A	A	C	C	C	A	C	–	A
Sodium perborate	C	A	–	C	C	C	C	A	C	–	A
Sodium peroxide	C	A	–	C	C	C	C	A	C	–	A
Sodium phosphate, monobasic	A	C	A	A	A	C	A	A	A	A	A
dibasic	A	A	A	A	A	C	A	A	A	A	A
tribasic	A	A	A	A	A	C	A	A	A	A	A
Sodium silicate	A	A	A	A	A	A	A	A	A	–	A
Sodium sulphate	A	A	A	A	A	A	A	A	A	–	A
Sodium sulphide	A	A	–	A	A	A	A	A	A	–	A
Sodium thiosulphate, "hypo"	A	A	A	A	–	A	A	A	A	A	A
Soybean oil	A	A	–	C	A	A	A	F	C	C	A
Stannic chloride	A	C	A	A	A	A	A	F	C	C	A
Steam, <500 deg. F.	C	A	–	A	C	A	A	–	C	X	A
500–1,000 deg. F.	C	A	–	X	X	X	X	–	X	X	A
>1,000 deg. F.	X	C	–	X	X	X	X	–	X	X	A
Stearic acid	A	A	X	C	A	A	A	C	C	C	A
Sulphur	A	A	–	F	A	F	X	C	F	X	A
Sulphur chloride	C	X	–	X	F	C	C	A	C	X	A
Sulphur dioxide, dry	A	A	–	C	C	C	A	A	C	C	A
Sulphur trioxide, dry	–	A	–	C	C	C	A	A	–	–	A
Sulphuric acid, <10%, cold	A	F	A	A	A	A	A	A	A	–	A
hot	A	F	X	C	C	C	A	A	A	–	A
10-75%, cold	F	X	X	C	C	C	A	A	C	–	A
hot	F	X	X	C	C	C	A	A	C	–	A
75-95%, cold	C	X	X	C	C	C	A	C	C	X	A
hot	C	X	X	C	C	C	A	C	C	X	A
fuming	X	X	X	X	X	X	C	X	X	–	A
Sulphurous acid	A	X	A	C	C	C	C	A	C	–	A
Tannic acid	–	A	A	C	C	C	C	A	C	–	A
Tar	A	A	–	C	C	C	C	A	C	X	A
Tartaric acid	–	A	A	C	F	C	C	A	C	–	A
Toluene	A	A	X	X	F	A	X	X	X	X	A
Trichloroethylene	C	A	X	X	F	A	X	X	X	X	A
Turpentine	A	A	X	X	C	A	X	X	X	X	A
Vinegar	A	A	A	C	C	C	A	C	C	X	A
Water, acid mine, cont'g oxidizing salts or no oxidizing salts	A	A	A	A	C	A	A	A	A	C	A
Water, fresh (tap, b'l'r f'd,etc.)	A	A	A	A	C	A	A	A	A	A	A
distilled, lab. grade	A	A	X	A	C	A	A	A	A	A	A
return condensate	A	A	C	A	C	A	A	A	A	A	A
Water, seawater	A	A	A	A	C	A	A	A	A	A	A
Whiskey and wines	A	A	X	A	C	A	A	A	A	A	A
Zinc chloride	C	X	A	C	A	C	A	A	C	A	A
Zinc sulphate	A	X	A	A	A	A	A	A	A	A	A

For more data on advertised products, use Readers' Service Cards, last page.

Chemical Resistance of Gasket Materials

This chart enables you to select accurately the right "U.S." Gasket for corrosive service

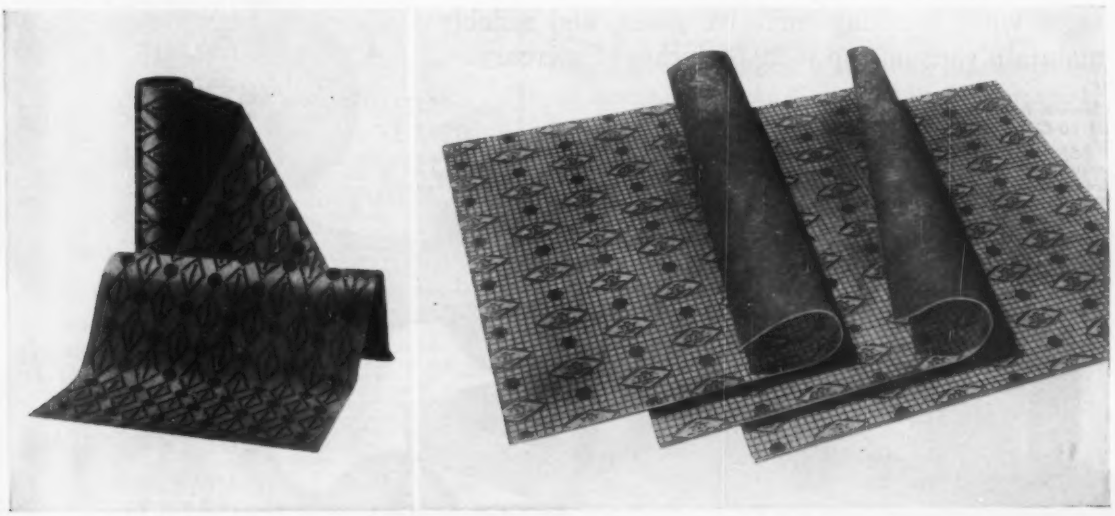
SEND FOR YOUR FREE REPRINT NOW

The chart will be useful in indicating the degree of safety with which the various materials may be used in the service shown.

Those materials known to be suitably resistant have been rated as "A". Those whose resistance is only fair, but not so low as to be dangerous, have been given an "F" rating. An "X" denotes that the material is totally unsuitable. The "C" rating means that the use of this material is dependent upon specific service conditions and should not be selected unless carefully investigated. The blank spaces for the most part represent absence of data.

The generally accepted temperature limit for a good grade compressed asbestos sheet, also called asbestos composition sheet, is 750° F. However, some grades are successfully used at considerably higher temperatures. This type of sheet is used for smooth flanges. For rough flanges, gaskets cut from woven asbestos-metallic sheet or gaskets formed by folding asbestos-metallic cloth are preferred. The latter material is preferable for flanges when bolt pressures are necessarily limited to the type of flange material.

The all-rubber materials are recommended for temperatures up to 300° F. Higher temperatures are sometimes used but with a lesser degree of safety. Pressures are determined by the type of flange surface.



These are outstanding members of the "U. S." line of Sheet Packing—Nos. 899 and 9. They are recommended for packing flanges or other parallel surfaces against the many chemicals listed on the opposite page.

When you think of packing, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

US RUBBER

Mechanical Goods Division

United States Rubber

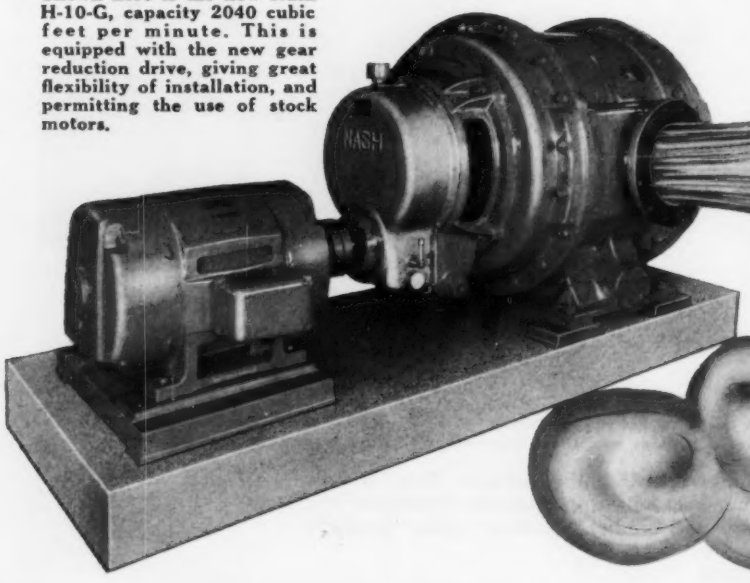
WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Nash Compressors Tame "Hard-to-handle" Corrosive Gases

The reasons for the success of Nash Compressors in handling "dirty" and corrosive gases are simple. First, Nash Compressors have no internal parts in wearing contact, or requiring close tolerances and internal lubrication. Second, because of the Nash operating principle, a variety of liquids can be employed as the compressant medium, protecting the interior from corrosive action. Third, the pump casing may be fabricated from a variety of special metals and alloys. That is why Nash Compressors take these rugged jobs in stride.

Nash Vacuum Pumps offer the same basic advantages when handling corrosive gases, and reliably maintain vacuums up to 29.50 inches of mercury.



Shown here is the new Nash H-10-G, capacity 2040 cubic feet per minute. This is equipped with the new gear reduction drive, giving great flexibility of installation, and permitting the use of stock motors.

ACETONE
ACETYLENE
AMMONIA
ARGON
BUTADIENE
CARBON DIOXIDE
CARBON MONOXIDE
CHLORINE
ETHYL CHLORIDE
FLUE GAS
FURFURAL
HEXANE
HELIUM
HYDROGEN
HYDROGEN SULPHIDE
NITROGEN
OXYGEN
PHOSPHOROUS PENTOXIDE
SULPHUR GAS
VINYL ACETATE
VINYL CHLORIDE
AND MANY OTHERS

NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

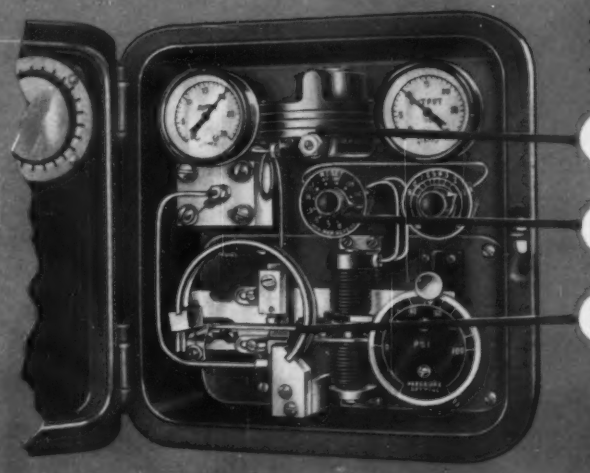
How to get ACCURATE PRESSURE CONTROL IN SPITE OF DEMAND CHANGES

ask your **FISHER/MAN** about the

WIZARD II

PRESSURE CONTROLLER

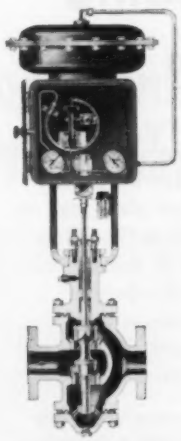
with new and improved features



1. **VOLUME RELAY** for faster response to pressure changes.
2. **RESET FEATURE** for greater stability and pin-point control, adjustable from .005 to 1 minute per repeat.
3. **MEASURING ELEMENT** may be brass, steel or stainless steel Bourdon tubes for pressures from 30 to 15,000 psi or Bellows assemblies for pressures below 30 psi and vacuum.

WIZARD I

PRESSURE CONTROLLER



The original Wizard I Pressure Controller is still available for those applications not requiring volume relay or reset features. The simplicity of a self-operated regulator and the accuracy of a pilot or relay operated regulator are found in the Series 4100U. This is, unquestionably, the reason for the continued popularity of the Wizard I series.

As for all Wizards, the Series 4100U is furnished with a universal case which enables the unit to be flush or surface mounted or mounted on yoke of a control valve. Measuring Elements: Bourdon Tube—Bronze, Steel or St. Steel—Ranges 25 to 7,500 psi. Bronze or St. Steel Bellows for vacuum to 25 psi.

The Wizard II has been designed to specifically meet the demands of modern, complex systems requiring closer and faster control. The Wizard II retains the basic simplicity and dependability of the Wizard 4100U, plus more speed and accuracy.

The new design consists of two sub-assemblies encased in a weather proof die cast aluminum housing which is provided with a ¼" pipe threaded vent. Either sub-assembly can be removed without disturbing case mounting. The simple but effective proportional band adjustment (2 to 100%) and the reset adjustment (.005 to 1 min/repeat) along with ease of reversing the action of the Wizard II, have contributed much to its popularity in process control work. All Wizard II controllers, with exception of differential models, can be supplied with a process or controlled pressure gauge installed inside the case.

Careful and exhaustive tests and years of field use have conclusively proved that the Wizard II measures up to rigid Fisher standards.

A COMPLETELY DESCRIPTIVE AND ILLUSTRATED BULLETIN ON THE WIZARD II IS YOURS FOR THE ASKING. WRITE FOR BULLETIN No. D-4150B OR BULLETIN D4100 ON WIZARD I.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIP. CO., CORAOPOLIS, PA.

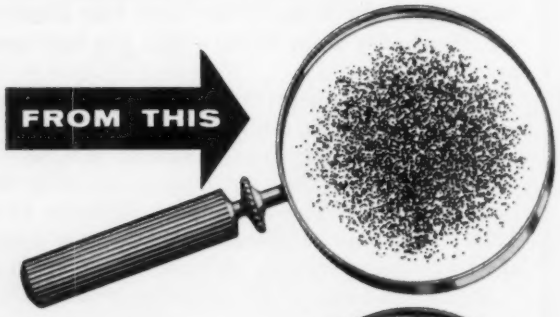
FISHER® Controls

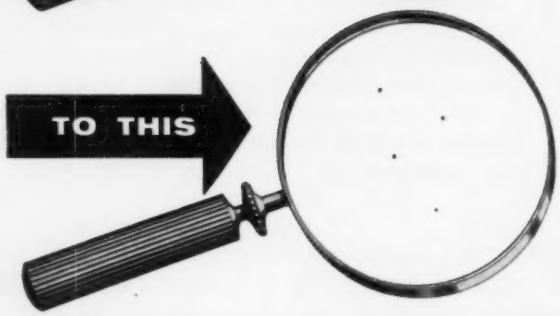
SINCE 1880

This is a Dust Particle

This is a Cyclo-trell Dust Collector →

The Cyclo-trell Dust Collector Cleans Gas with these Dust Particles...





Result: Efficiencies Exceeding 98%

This is a fact. If you have a process or cleaning problem in steel mills, refineries, paper, cement or chemical plants, call on Research-Cottrell. • We will be glad to consult with you on your specific dust collection problems, and place at your disposal the largest research and engineering facilities.

For further information, write for Bulletin 300 which describes several applications in detail.

Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, New Jersey

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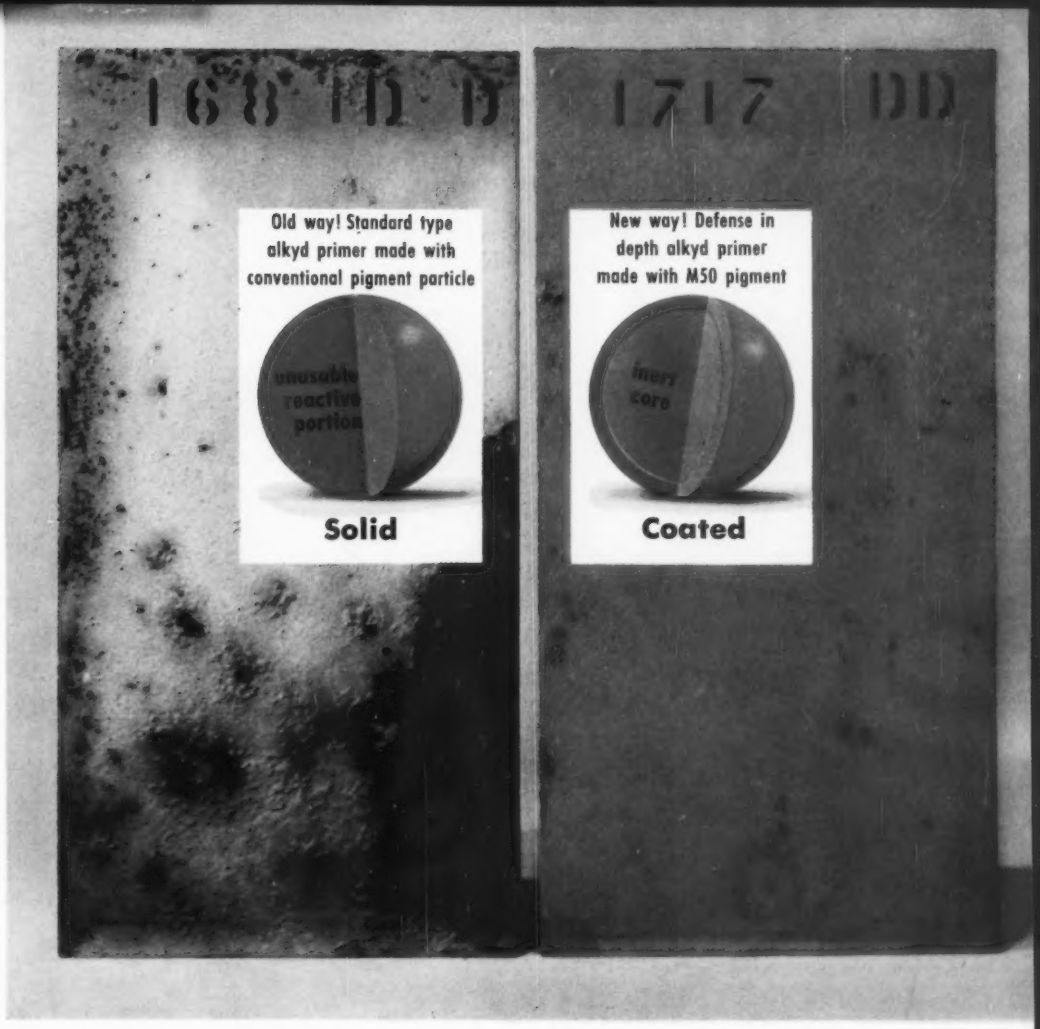
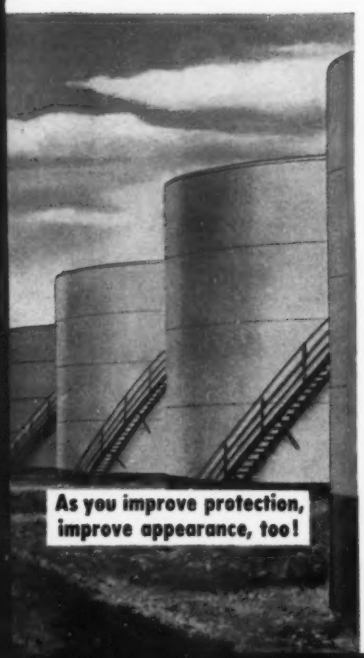
RESEARCH COTTRELL INC TRADE MARK

RC-300

Never before such durable tank protection



Proof tank paints with M50® pigment form rust-inhibitive films of outstanding strength and durability



Test panels like these *prove* what paints can do. And these two make it plain that paints containing *M50* basic lead silico chromate—a new National Lead rust-inhibitive pigment . . . form outstandingly strong and durable protective films.

Excepting the pigment, both primers shown on the test panels contain the same ingredients. Both are applied (2.0 mils, dry) on rusted and mill-scaled steel (to increase test's severity). Both have been exposed 12 months in industrial atmosphere (Perth Amboy, N. J.) and 12 months in normal atmosphere (Sayville, L. I.) at 45° South. You can see the effect.

A striking difference! Yet film strengthening proves to be only one of many improvements that *M50* pigment makes in metal protective paints for steel tanks and structures. Now—with new *M50* pigment—your regular paint suppliers can provide metal protective paints with outstanding advantages:

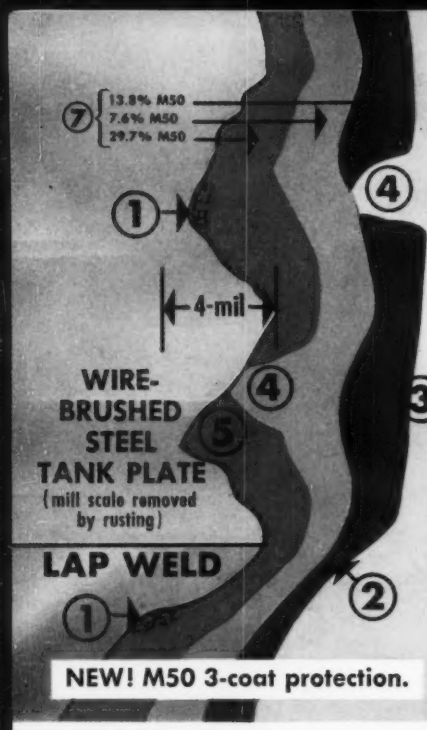
- Weather-resistant anti-corrosive primers.
- Intermediate and finish paints *with* exceptional rust inhibition but *without* bilging hazard in sulfur-laden atmospheres.
- Finish paints in a wide range of decorative colors that don't fade or wash out.
- Alkyd-type conventional and deep-coat paints with outstanding durability, package stability and sprayability.

What makes the difference? Basically the differences that make a difference in *M50* pigmented paints are inherent in the unique *M50* coated pigment particle itself (idealized particle shown above.) See, on the next page, the extra protections the *M50* particle provides in the dried film. See, too, how you can get the benefits of these new, much more durable, anti-corrosive paints.

M50 *an* **oncor** TRADEMARK *pigment development of*

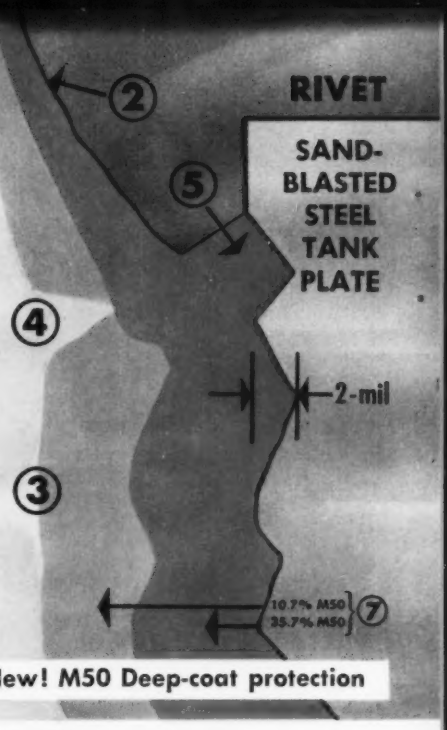
National Lead Company

111 Broadway, New York 6, N. Y.



NEW! M50 3-coat protection.

1. **Pockets of rust prove less harmful** on steel surfaces painted with conventional *M50* paints. Vehicles penetrate and isolate existing rust. *M50* particles stop rusting action.
2. **Where paint film lies thin** over tiny surface projections and sharp structural edges, the *rust-inhibitive* pigment content in all coats of *M50* paints provides extra protection.
3. **Just-right flow characteristics of** package-stable *M50* paints aid leveling on rough steel surfaces, promote smoothness, good appearance.
4. **Inevitable "holidays" in film** do not destroy protection. Again, *all M50* coats have both rust inhibition *and* weather resistance.
5. **M50 paints "wet" well,** penetrate pits and crevices, carry *M50* protection to every part of these danger spots.
6. **Lightweight M50 particle** aids formulation of new type deep-coat paints with *uniform* rust inhibition throughout the film and low sag characteristics.
7. **Every coat can have rust inhibition**—not just the primer. Note percentages of *M50* in dry films. What's more, for equal weights of corrosion-inhibitive pigment, *M50* primers contain 40-60% more corrosion inhibition by volume than non-*M50* primers.



New! M50 Deep-coat protection

Sections through M50 Defense in Depth films show dramatic extra protection these new tank paints provide

Information on the preceding page proves that *M50* pigment paints form stronger protective films than anti-corrosive paints made with other rust-inhibiting pigments. The sections above show some of the ways in which these new paints perform better in the dry film. Below you will see *proof* that *M50* metal protective paints don't bilge, are unique for color stability and the color range in which they can be made.

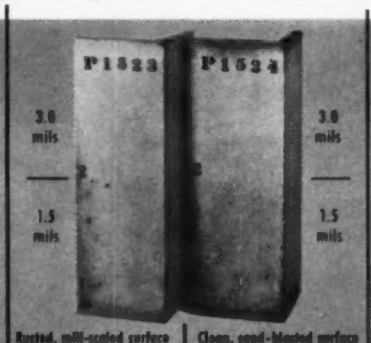
Hold the *M50* pigment particle itself responsible for all these improvements . . . *Basic lead chromate* is known for exceptional rust-inhibiting action. In the *M50* particle, this reactive business portion of the particle is coated on an inert core . . . where *all of it is available* to react. The coating is *fused* on—shows superior resistance to chalking, erosion, chemical action. Unusual tintability is due to the geometric configuration of the coated silica particle.

Why M50 Defense in Depth paints give anti-corrosion beyond all former concepts

2 standard pigment alkyd primer coats
Gray Alkyd Finish Coat
1 standard pigment alkyd primer coat
2 M-50 pigment alkyd primer coats
1 M-50 pigment alkyd primer coat

Exposed 9 years, 45°S. Each coat 1.5 mils

Proved corrosion and weather resistance



Exposed 4 years adjacent to refinery

Proved anti-bilging performance

Available in conventional and heavy-coat paints

Proved stability in wide range of colors

Are you concerned with tank or structure maintenance painting in your firm? If so, you are invited: (1) to visit National Lead's Sayville, L.I. test station, where you will see the results of the 20 years research that lies behind the *M50* pigment particle and the more than 10 years of exposure testing that lies behind *M50* pigment Defense in Depth paints; (2) to send coupon below for National Lead booklet, "Defense in Depth" and typical *M50* tank paint specifications.

Next time you purchase, specify *M50* pigment paints. Any paint manufacturer can supply you.

M50 Defense in Depth

National Lead Company,
111 Broadway, New York 6, N. Y.

anchor TRADEMARK

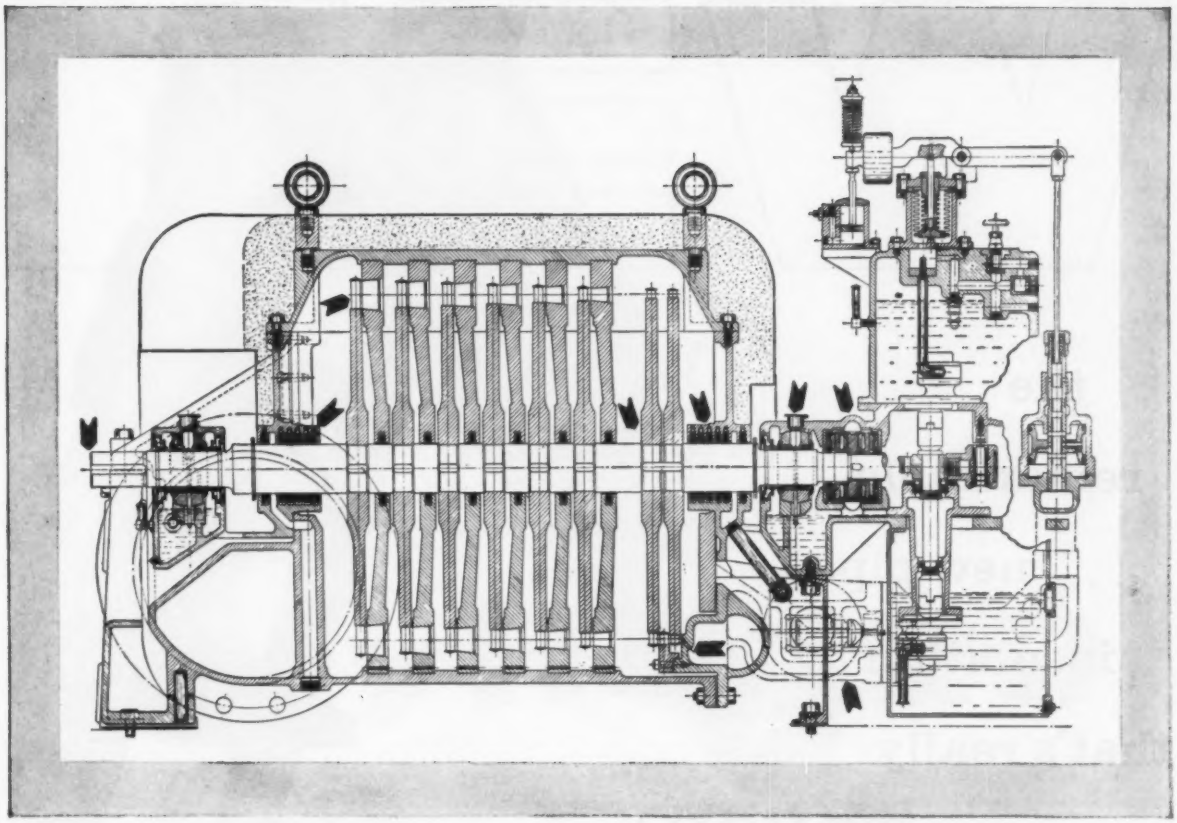
Gentlemen: Please send me the "Defense in Depth" booklet together with typical tank paint formulas and color chips that I can use in specifying M50-type tank paints.

Name_____ Title_____

Firm or Dept._____

Address_____

City_____ State_____



ANOTHER INSIDE STORY OF THE UNIVERSAL ACCEPTANCE OF MURRAY MULTI-STAGE TURBINES IN THE MECHANICAL DRIVE FIELD

- Husky accurately machined shaft.
- Discs shrunk and keyed in place.
- Stainless steel nozzles and blading throughout.
- Spherical seated sleeve bearings.
- Kingsbury thrust bearing.
- Center line support.
- Carbon ring gland seals.
- Double seated balanced governor valve – stellited.
- Choice of speed governors from simple mechanical type to precision oil relay.
- Bolt type overspeed trip governor.
- Steam conditions to 600 PSIG and 750°F.
- Condensing or non-condensing.

Our nearest representative will gladly help you solve your mechanical drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA
Builders of Steam Power Equipment for Nearly a Century

For more data on advertised products, use Readers' Service Cards, last page.

the remarkable new pipe insulation that's really TOUGH!

ZEBRA

You don't have to handle Zebra with kid gloves. This multi-layer sectional-type thermal insulation has real body . . . doesn't break easily. In fact, its deflection at breaking point is 2 to 4 times that of ordinary insulation.

A low, medium, and high-*temperature* pipe insulation, Zebra is made in half sections in all pipe sizes to facilitate handling and reduce the number of joints. This, plus its light weight, speeds application and keeps installation cost *low*. Zebra is easy to cut and fabricate. And it's reusable . . . can be dismantled and re-applied.

What's more, Zebra won't cause skin irritation or cuts. It has a smooth surface . . . no ragged ends. And it's practically dust free.

• for temperatures of 200° F to 1200° F • made of calcium silicate-asbestos fibre bonded felts • withstands shock and heat without warping or abrading • meets requirements for density, conductivity, modulus of rupture • available in wide range of sizes and thicknesses • tested by an independent testing laboratory

Write today for more information on "K&M" Zebra—the remarkable new pipe insulation that's really tough! Keasbey & Mattison Company, Ambler, Pa., Dept. I-290. In Canada, Address: Atlas Asbestos Company, Ltd., 5600 Hochelaga St., Montreal 5.

K·M
BEST IN ASBESTOS

Keasbey & Mattison at Ambler

NEW

low-cost,
high-potency
fuel oil additive

polyflo 120™

***See your PSE**

Correct selection and most effective use of petroleum inhibitors and additives involves expert analysis and consideration of many factors. As specialists for over a quarter-century, UOP is able to provide unparalleled field service, brought to you by a member of our staff of Product Sales Engineers®. For detailed information on the UOP family of superior inhibitors and additives call or write our Products Department.

- Especially suitable for treating

  No. 2 HEATING OIL and DIESEL FUEL BLENDS

- Maintains fuel oil stability through seasonal storage—even in high summer heat
- Highly effective as color stabilizer—sediment inhibitor—anti-emulsion agent
- Enhances action of other additives, such as copper deactivator
- *Treatment costs only one-fourth to one-half cent per barrel of product.*

Write for information and samples. Address our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.
WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

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GET PREDICTABLE, DEPENDABLE SERVICE EVERY TIME . . .

FARROWTESTED

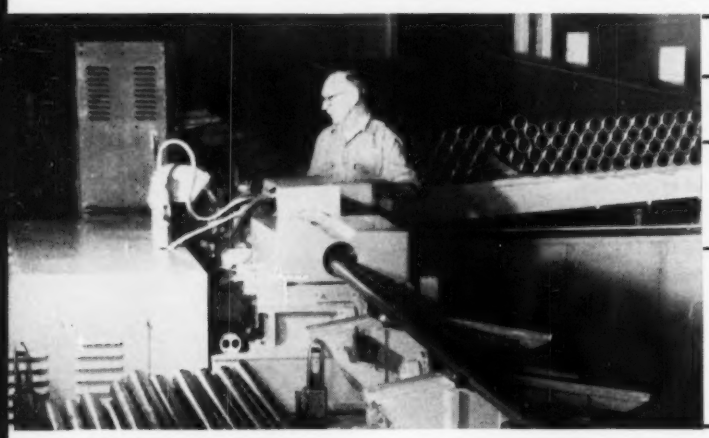
Heat exchanger tubing . . . carbon and stainless steels

Get predictable, dependable service everytime. Specify Republic ELECTRUNITE® Heat Exchanger Tubing which has passed the most searching test of all—FARROWTEST®.

FARROWTEST is Republic's exclusive non-destructive eddy-current test that probes for and detects injurious defects so small that they pass ordinary internal fluid or gas pressure tests. FARROWTEST looks deep within the tube wall, is calibrated to reject tube with defects as shown in the table below.

FARROWTEST is offered as an alternative to other less positive tests at no increase in cost. Carbon steel Heat Exchanger Tubes produced to ASTM specification A-214; stainless steel Heat Exchanger Tubes to A-249. Both specifications include eddy-current requirements.

As a tube buyer and user, you owe it to yourself and your company to get ELECTRUNITE and FARROWTEST facts firsthand. Call your Republic representative. Or, write direct.



FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006″	.0025 sq. inches
18	.006″	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

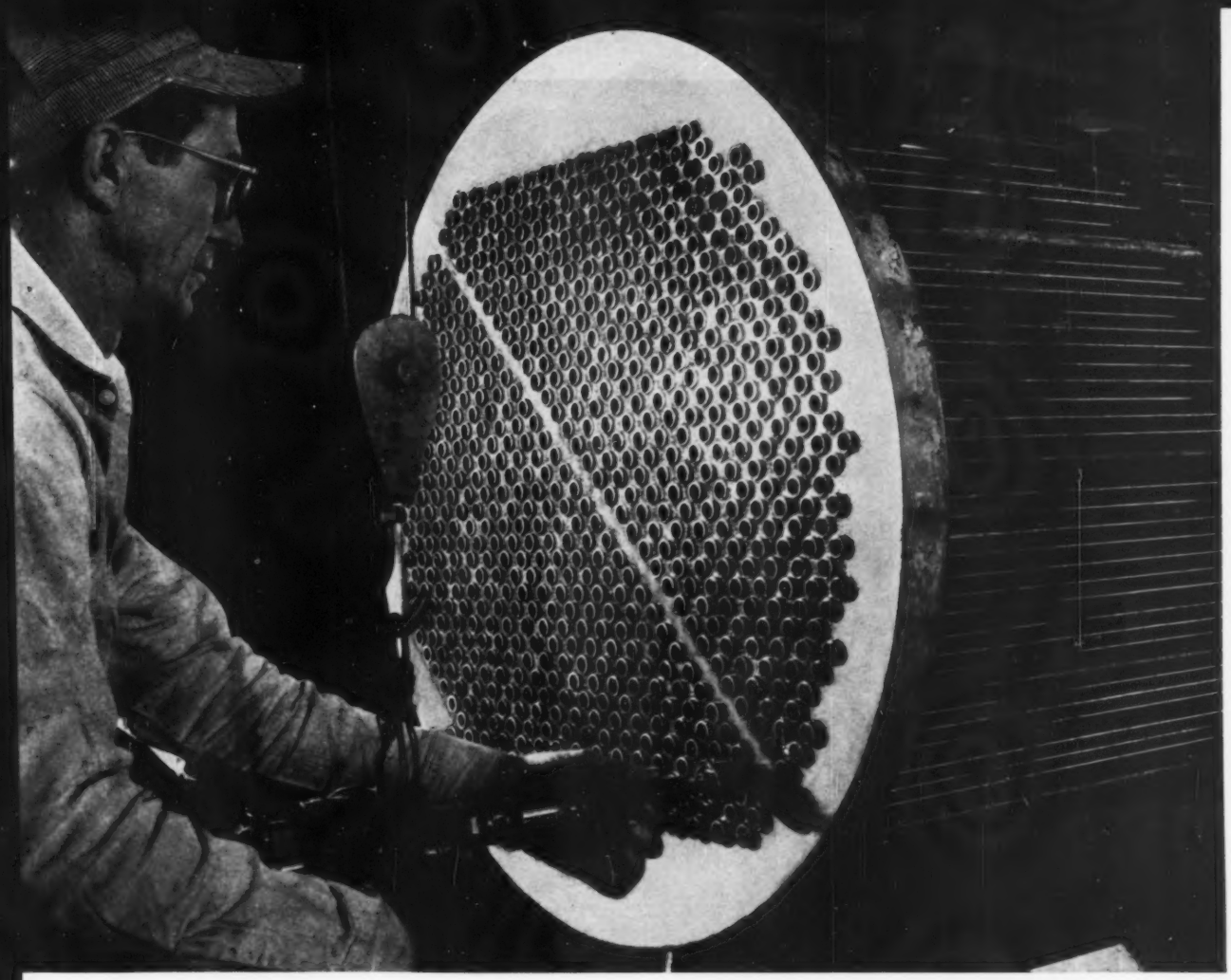
FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

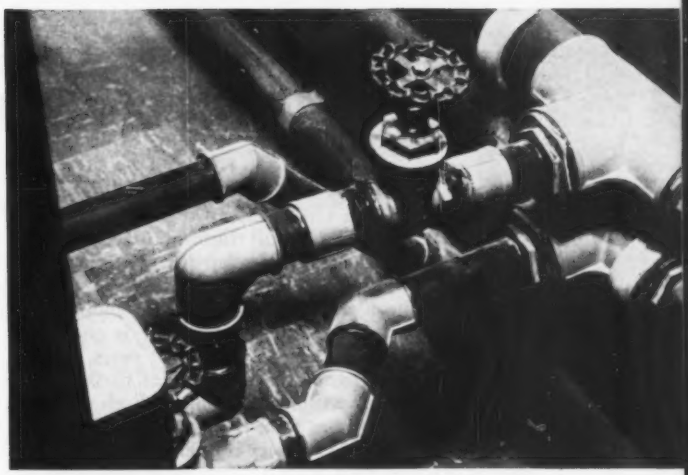
FARROWTEST—quality measured for you. Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with the table, at right, at no extra cost.

REPUBLIC STEEL

DEPT. PR-8834 · 1441 REPUBLIC BUILDING

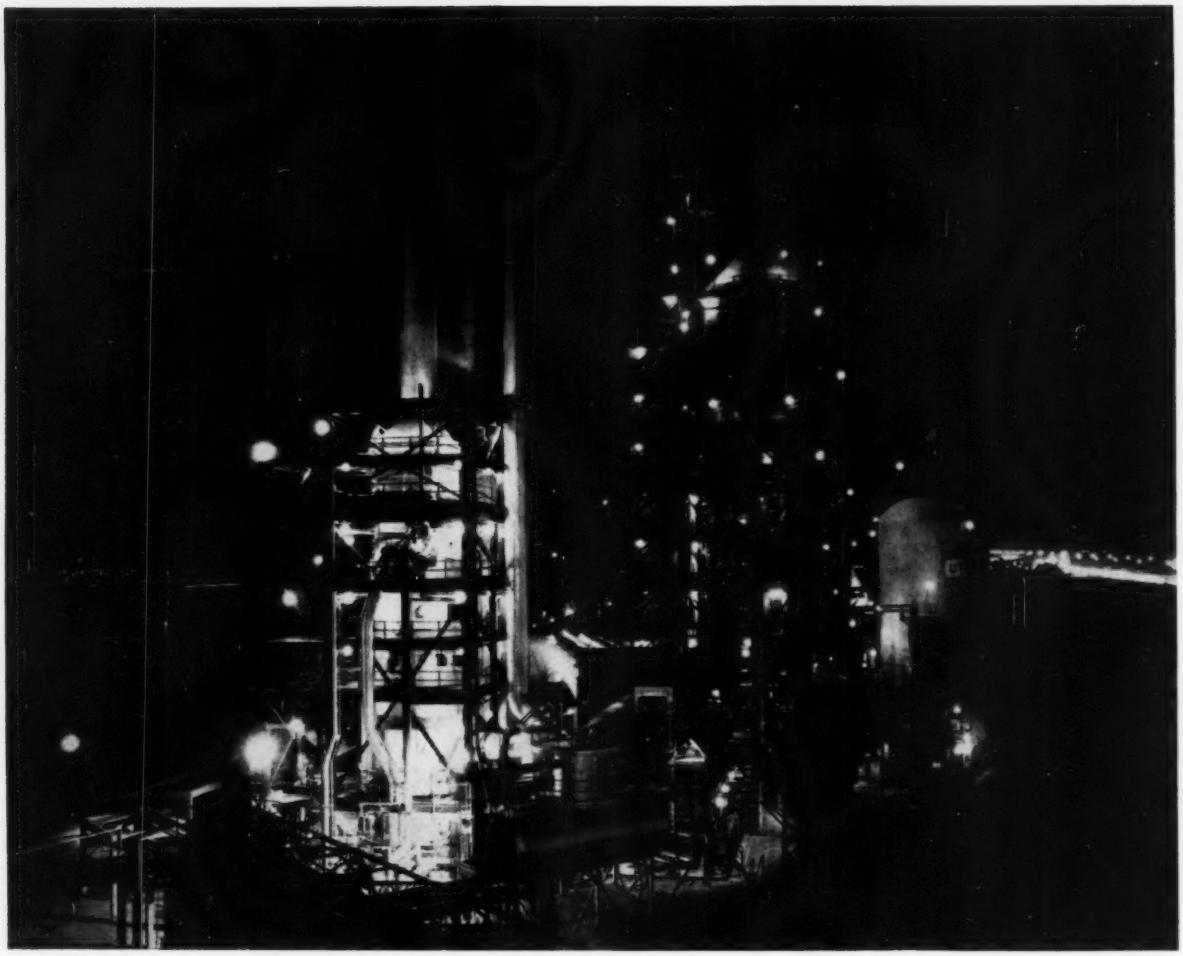
CLEVELAND 1, OHIO





REPUBLIC SRK PLASTIC PIPE is extensively used to make up spray headers and bars in cooling towers. SRK resists corrosion and scale build-up. It is tough yet light in weight and easy to handle, and eliminates heavy supports required with conventional piping. SRK also is widely used for carrying corrosive fluids and wastes.

REPUBLIC ALLOY STEEL STUDS AND HIGH CARBON HEX NUTS provide the strength needed in high pressure equipment. High tensile strength with tough threads offers maximum holding power and resistance to wear. Tighten smoothly, back-off easily. Write for data and details.



Utah Oil Company's story tells why...

Modern Refineries Are Choosing B&W CO® Boilers

In May, 1958, a Babcock & Wilcox CO Boiler went on stream at Utah Oil Company's Salt Lake City refinery. Results: 1) Fuel-oil consumption has been about 55 to 60% of that needed for conventional boilers. 2) Incremental payout of the CO Boiler over that of conventional equipment is about 2.2 years, after taxes. Fuel-oil saving alone is enough to pay out the entire investment in 6.2 years, after taxes. 3) Maintenance costs are equal to or less than those for conventional equipment. Both water-side and fire-side tubes were clean after 24 months' operation. 4) The CO Boiler is operated as part of the cat cracking unit, with no increase in personnel.

The unit can generate 138,000 lb of steam per hour at 300 psig and 540 F. The boiler can operate on oil plus combustibles in the cat cracker regenerator flue gas, or on oil alone.

The CO Boiler was installed to take care of increasing steam requirements. The sensible heat of the waste regenerator gases was already removed with an existing waste heat boiler. Selection of a CO Boiler over conventional steam-generating equipment was made to utilize the waste combustible heat from the 17,500 bbl/D fluid unit, and to utilize existing manpower.

CO Boilers are setting similar performance and economy records in refineries throughout the world. The B&W CO Boiler is the only unit specifically designed for efficient burning of "waste" carbon monoxide. Check your own steam costs—then check with us and learn how a CO Boiler can cut those costs. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

CO-107

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

For more data on advertised products, use Readers' Service Cards, last page.

the only complete line to handle every pipe movement problem!

Flexonics Expansion Compensators

Flexonics Expansion Joints

Flexonics Flexible Connectors

Flexonics Pipe Guides and Supports

Wherever there's pipe movement . . . thermal growth . . . vibration . . . there's a Flexonics product to absorb, guide, or control it.

Flexonics Corrugated Expansion Joints are expertly engineered to your needs, hydraulically formed, metallurgically treated by exclusive techniques, for maximum cyclic life **Flexonics Expansion Compensators** offer the lowest-cost way, inch for inch, to absorb thermal growth in pipes or tubing 3″ and smaller. **Flexonics Flexible Connectors** absorb vibration, permit random movement in pipes up to 24″ **Flexonics Pipe Alignment Guides** and Roller Pipe Supports provide better guiding than old-fashioned methods, yet they cost less. **Check and mail the coupon today.**

Member Expansion Joint Manufacturers Association

EJ-255

Flexonics
corporation

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ont.

EXPANSION JOINTS · METAL HOSE · SYNTHETIC HOSE · BELLOWS · AERO/SPACE COMPONENTS

SUBSIDIARY OF CALUMET & HECLA, INC.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Flexonics Corporation
1336 South Third Avenue
Maywood, Illinois

Please rush me complete information on

- ☐ Expansion Joints
- ☐ Expansion Compensators
- ☐ Flexible Connectors
- ☐ Pipe Guides and Supports

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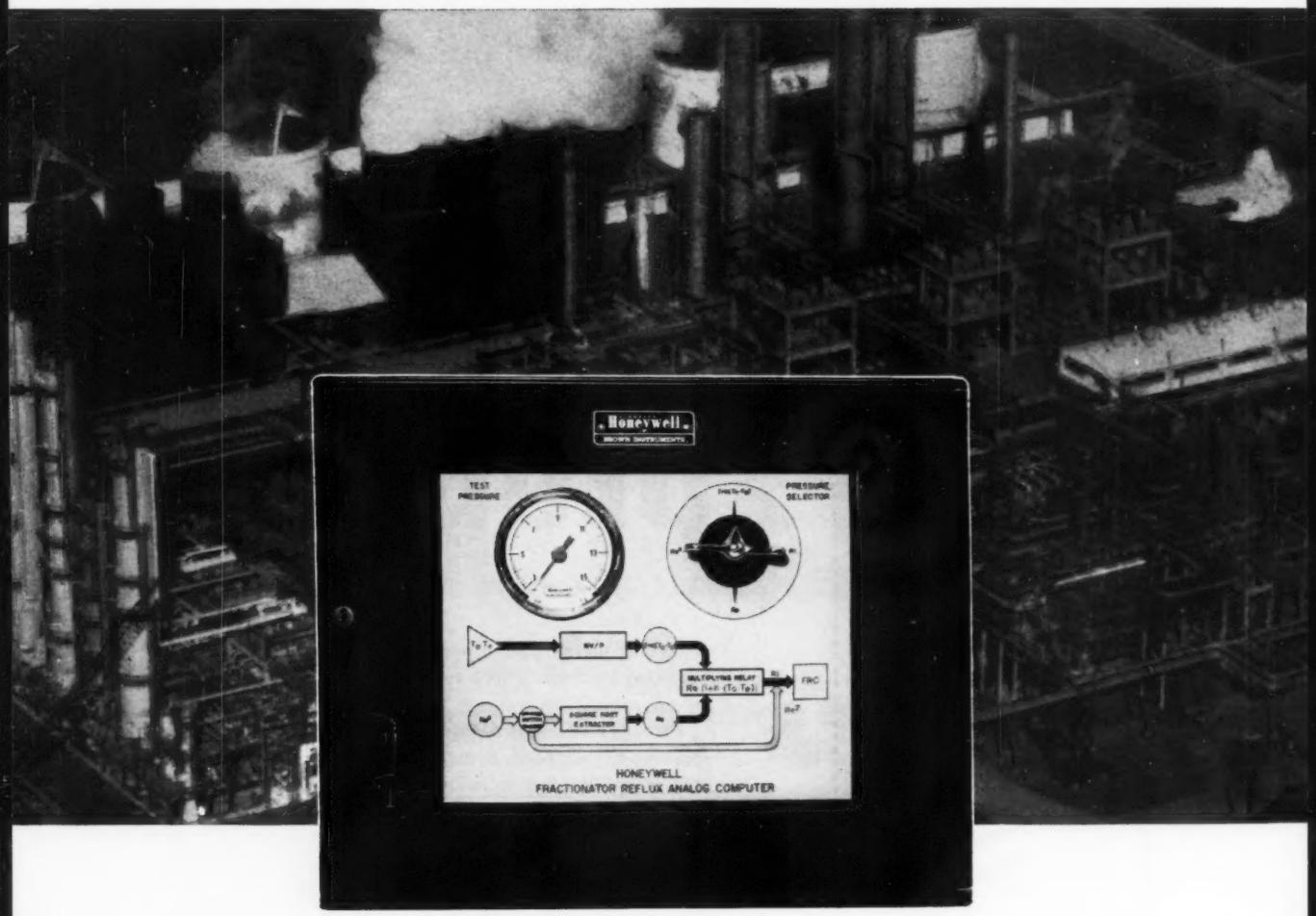
Stabilize Fractionating

with new Honeywell



HONEYWELL *FRAC* CONTROLLER IS EASY TO USE AND MAINTAIN

- Standard Honeywell components, packaged in a standard Honeywell strip chart recorder case—completely wired and internally piped.
- Only four simple, easily accessible process connections required to put the unit in operation.
- Chassis pulls out for front-of-case servicing, simplifying adjustment and maintenance for your instrument technicians.

COMPONENTS

MV/P (millivolt-to-pressure) Transmitter

- Fully transistorized
- Continuously sensitive to temperature change
- Constant voltage supply
- Simple span and zero adjustments

Pressure selector and test pressure gage

- Provide check of all pneumatic pressures within the computer for simplified trouble shooting.

By-pass switch

- Permits switching from *FRAC* control to conventional external reflux flow control.

Column Operation

*FRAC** Controller

- **Easily installed and maintained by present instrument technicians**
- **Savings realized justify installation**
- **Tamper-proof design**

This new Honeywell control system immediately adjusts column operation to the effects of ambient temperature on overhead product condenser and external reflux. It continuously computes internal reflux flow, to maintain the most efficient, economical fractionating tower operation.

The new method, originally developed and licensed by Phillips Petroleum Company, utilizes a simple Honeywell analog computer employing standard Honeywell electric and pneumatic instrument components.

By correcting instantly for temperature deviation, the new control system offers the following economies.

- Less reboiler heat is required, because large surges of internal reflux that would lower temperature are eliminated.
- Reduction in off-specification product minimizes re-runs and the need for intermediate storage.
- Closer control permits fractionator to operate closer to the flooding point.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

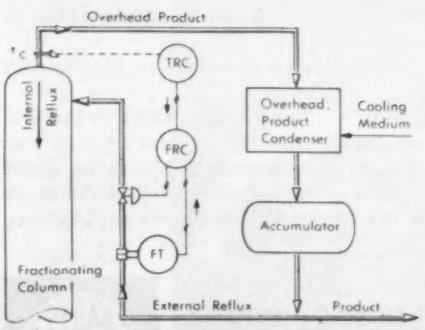
**Fractionator Reflux Analog Computer. Trademark, Minneapolis-Honeywell Reg. Co.*

from Honeywell... ANOTHER DIAMOND JUBILEE PRODUCT

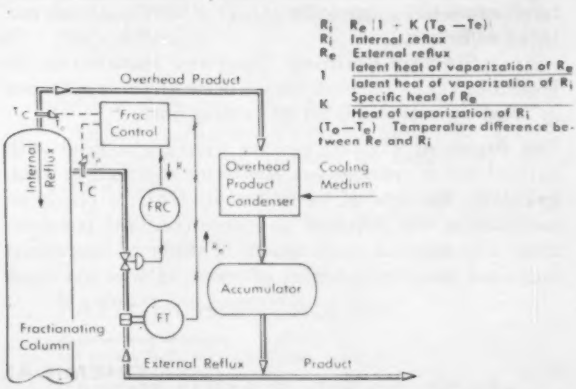
Honeywell

First in Control

SINCE 1885



PROBLEM with existing fractionator control systems—Column is upset when temperature of external reflux is indirectly affected by changes in atmospheric conditions or in the temperature of the cooling medium to the condenser. Result: off-spec product, wasted reboiler heat, lower fractionator capacity.



SOLUTION: FRAC Controller (1) measures external reflux flow rate (R_e) and the temperature difference between the overhead product (To) and the external reflux (T_e); (2) computes internal reflux flow rate (R_i); and (3) holds it constant by adjusting external reflux flow rate for efficient fractionator operation.

IN FIVE PLACES AT ONE TIME...

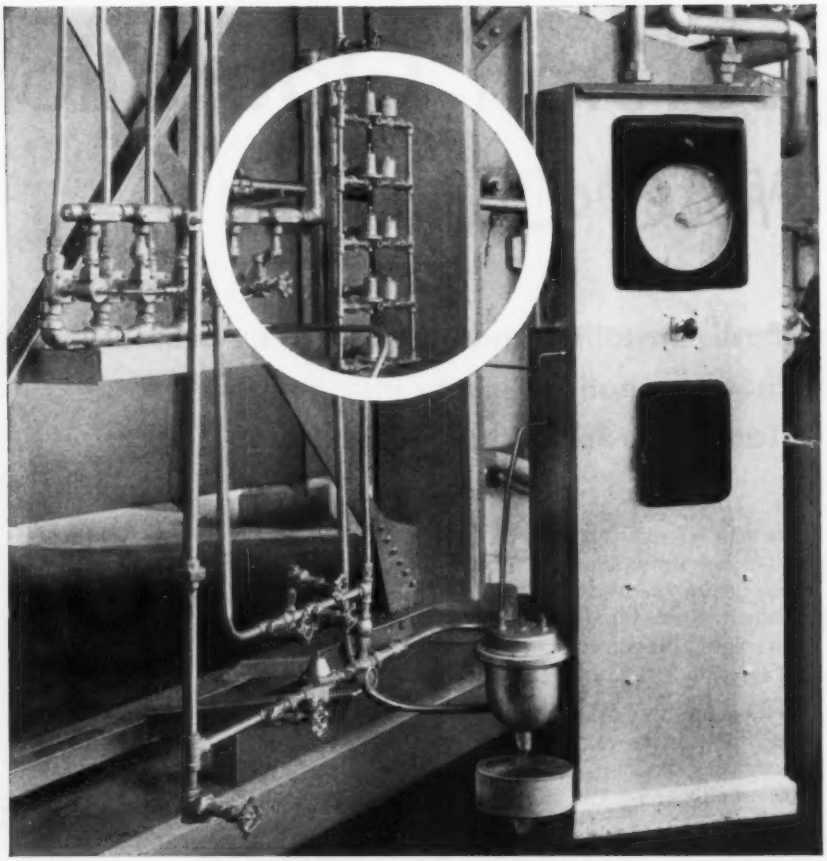


Photo courtesy Sinclair Refining Company

Multi-point sampling system solves oil-heater combustion control problem at a Houston refinery

To insure top combustion efficiency and fuel economy, an instrument engineer will locate continuous gas analyzers and recorders at each individual furnace or heater.

Where combustion conditions vary widely, this practice is most desirable. But where conditions are relatively stable for long periods, the practice may not be economical . . . portable HEAT PROVER analyzers being sufficient.

At a Sinclair Refining Company installation in Houston, Texas, the problem lay between these extremes . . . and the solution is an interesting one.

The Problem: Five oil heaters were to be fired with natural gas or refinery gas, the latter switched in when available. Because of variations in BTU, a check on combustion was required to insure constant temperatures and efficient combustion. A study of operations indicated that the interval of checking was too short for proper use of HEAT PROVER analyzers yet too long to justify individual analyzers and recorders.

The Solution: A Bailey multi-point sampling system. It tied the five oil heaters to a single recording panel, automatically sampling each at a prescribed interval. A two-pen system records (1) per cent oxygen at each point, (2) the indentity of the heater measured. The system also provides a means of drawing gas samples from any heater at any time the operator wishes to recheck that station.

There are 13 other Bailey analyzers at this Sinclair refinery.

A Bailey Engineer will be glad to explain how this and other advanced Bailey instruments and controls can help you toward greater processing efficiencies. Refer to your phone book for the Bailey District Office, or write direct to our Chemical and Petroleum Division.

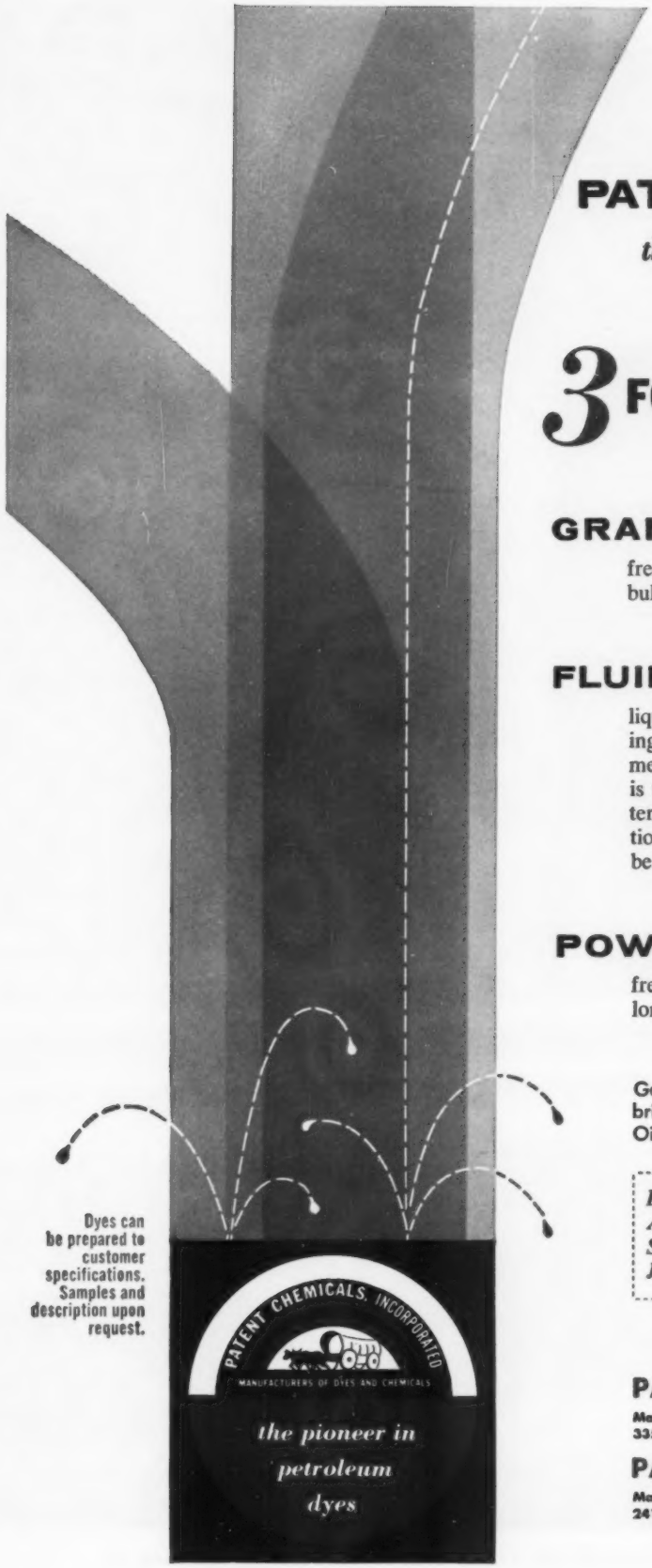
CP 109-1

CHEMICAL AND PETROLEUM DIVISION

BAILEY METER COMPANY

1043 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



Dyes can be prepared to customer specifications. Samples and description upon request.

and now

PATENT CHEMICALS

the Pioneers in Petroleum Dyes

OFFERS

3 FORMS OF COLORANTS

GRANULATED:

free flowing, uniform, lump-free, dust-free, low-bulk; extraordinary tinctorial values.

FLUID CONCENTRATES:

liquid for cleaner, easier use; eliminates pre-dissolving, dusting, operator exposure • less skill and equipment required • introduced directly into product it is the answer to bulk, tank-truck, tank-car, barge, terminal and pipeline coloring • involves no additional cost compared to ordinary dry dyes and can be used with dye eductor equipment.

POWDERED:

free flowing, non-caking, excellent solubility, stable, long storage characteristics.

FOR USE IN

Gasolines — Jet Fuels — Diesel Fuels — Fuel Oils — Lubricating Oils—Automatic Transmission Fluids—Break-in Oils and Greases.

Patent Chemicals also Features Multi-Purpose Additives, Rust and Corrosion inhibitors, Anti-Static Agents and Markers for Gasolines, and Jet Fuels.

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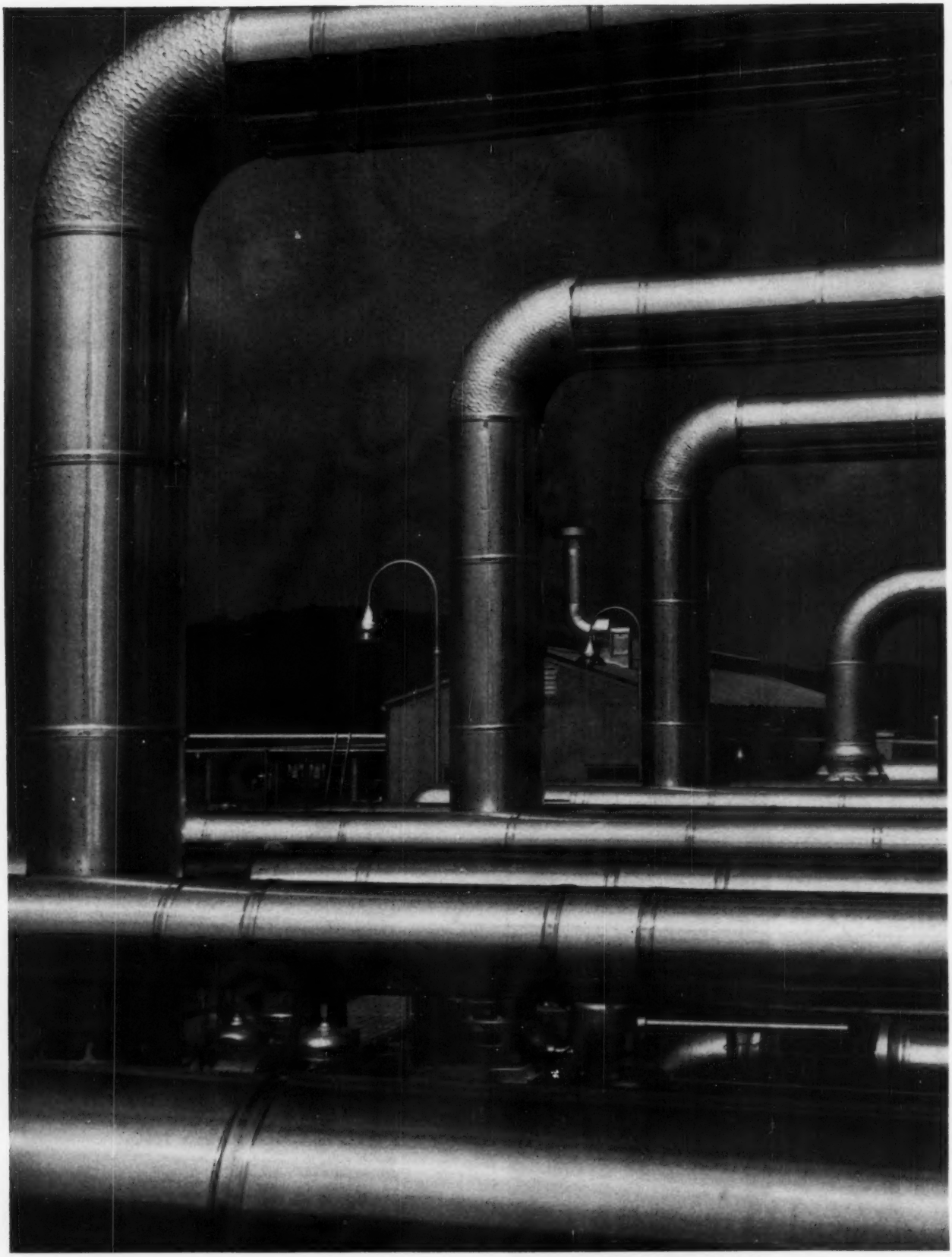
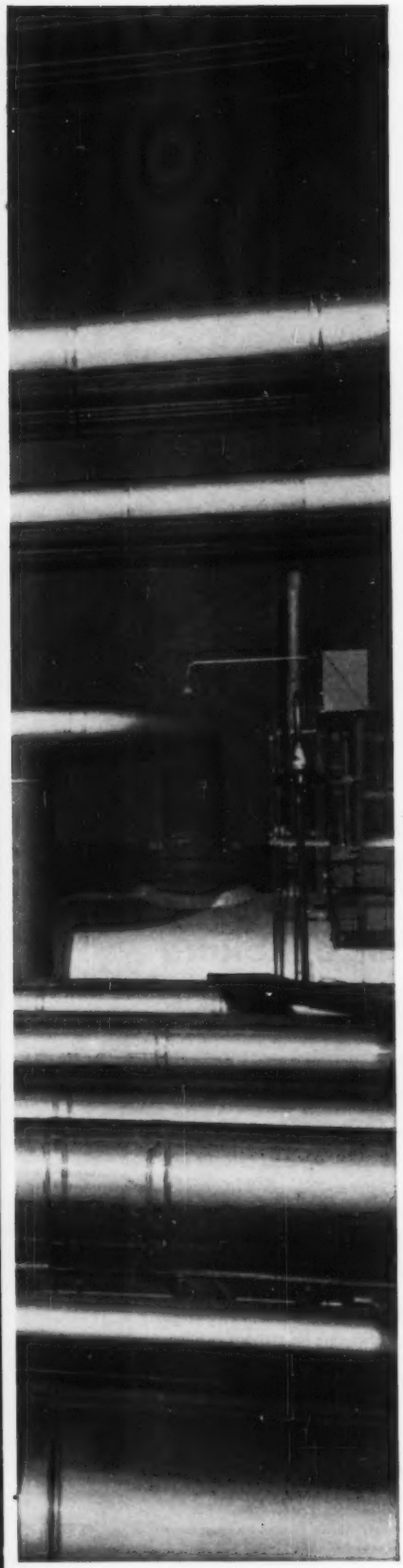
2410 Carew Tower Cincinnati 2, Ohio

For more data on advertised products, use Readers' Service Cards, last page.



PHOTOGRAPHED AT NEW YORK STATE NATURAL GAS CORPORATION'S LEIDY COMPRESSOR STATION, TAMARACK, PA.



Installation time at Leidy Station cut 25% with prejacketed J-M METAL-ON® pipe insulation!

"ALMOST 2 MILES OF METAL-ON PROTECTS OUR OUTDOOR PIPELINES. THIS IS THE BEST—AND BEST-LOOKING—INSULATING JOB I'VE EVER SEEN,"
says head station engineer VICTOR CUMMINGS

Leidy Pool, with an ultimate storage capacity of 105.6-billion cubic feet of natural gas, is served by a compressor station incorporating almost two miles of outdoor pipelines. Both lines and equipment must be completely protected against northern Pennsylvania's violent winter storms, torrential spring rains and summer heat. Metal-On jacketing, developed by J-M, was chosen to handle this difficult job.

Metal-On is prefabricated at the factory in 36-inch lengths. Each length combines high-temperature J-M Thermobestos insulation . . . a moisture barrier . . . and a special aluminum alloy jacket. And because each length can be applied in one simple operation, erection time savings at Leidy averaged 25%! Metal-On can also be easily cut on the job with portable power or hand saws. Cutouts for hangers and supports are simple to make.

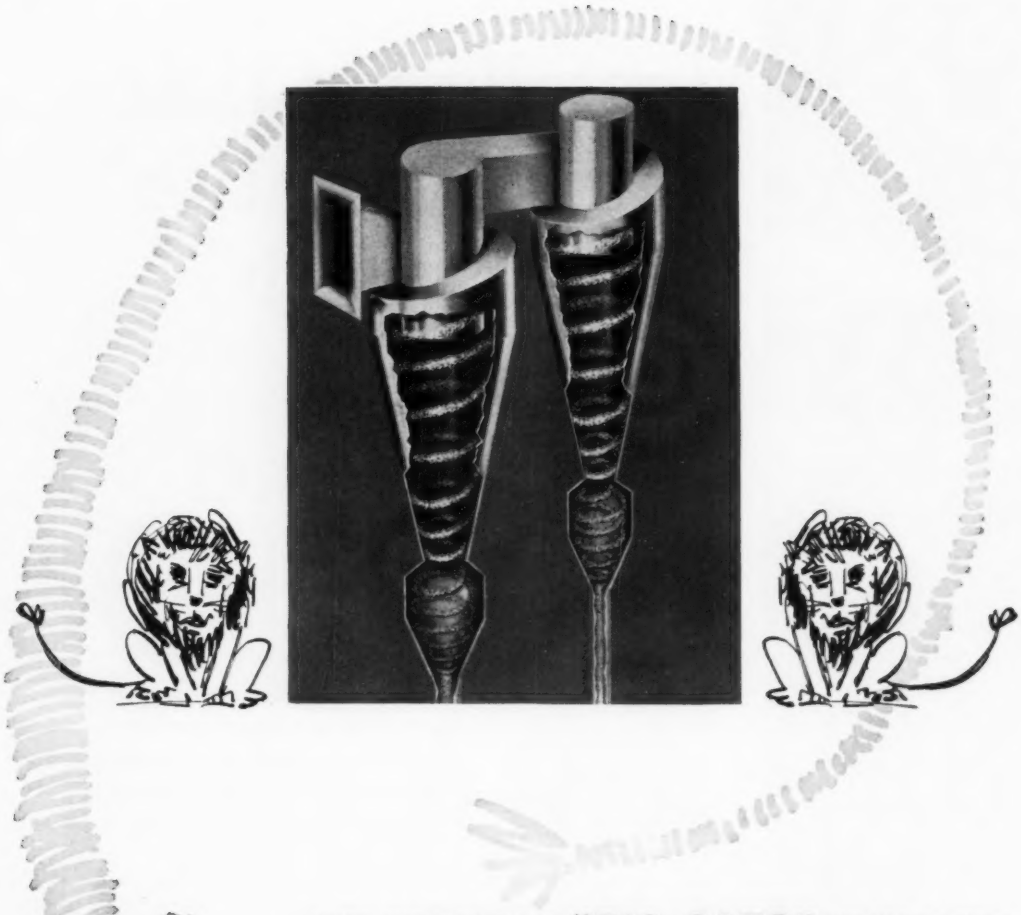
Maintenance savings can be very impressive, too. Metal-On doesn't corrode, needs no painting. The rugged jacketing, combined with a locking device that snaps closed and seals joints, will lock out weather and moisture permanently. And each section can be easily removed for trouble-shooting.

You may not have *two miles* of pipeline . . . but if you have a tough outdoor insulation problem, it will pay you to investigate J-M Metal-On. Just write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

METAL-ON:
JUST MINUTES FROM CARTON TO PIPE!

JOHNS-MANVILLE
AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

JOHNS-MANVILLE JM PRODUCTS



WE KEEP THE "BIG CATS" CRACKING

The "Big Cats," those steel behemoths that work wonders with the gasoline molecule, have a wild streak in them. Unless kept under control they can whip up a storm of flying catalyst dust that raises havoc with the operation and brings the Air Pollution Control people running.

To avoid this embarrassing and economically hazardous situation, refiners install our high efficiency SDC Duclones and Trickle Valves. They save money . . . improve performance . . . and in general do an admirable job. They snare each flying catalyst particle and plummet it back into the fluid bed to perform the miraculous task of catalytic cracking.

Is it any wonder that Duclones were used in two large refineries which set records for continuous on-stream service.

For more information on how SDC Duclones can keep "Big Cats" cracking, send for bulletin C-2058.

the name in Dust Control

THE Ducon COMPANY Inc.

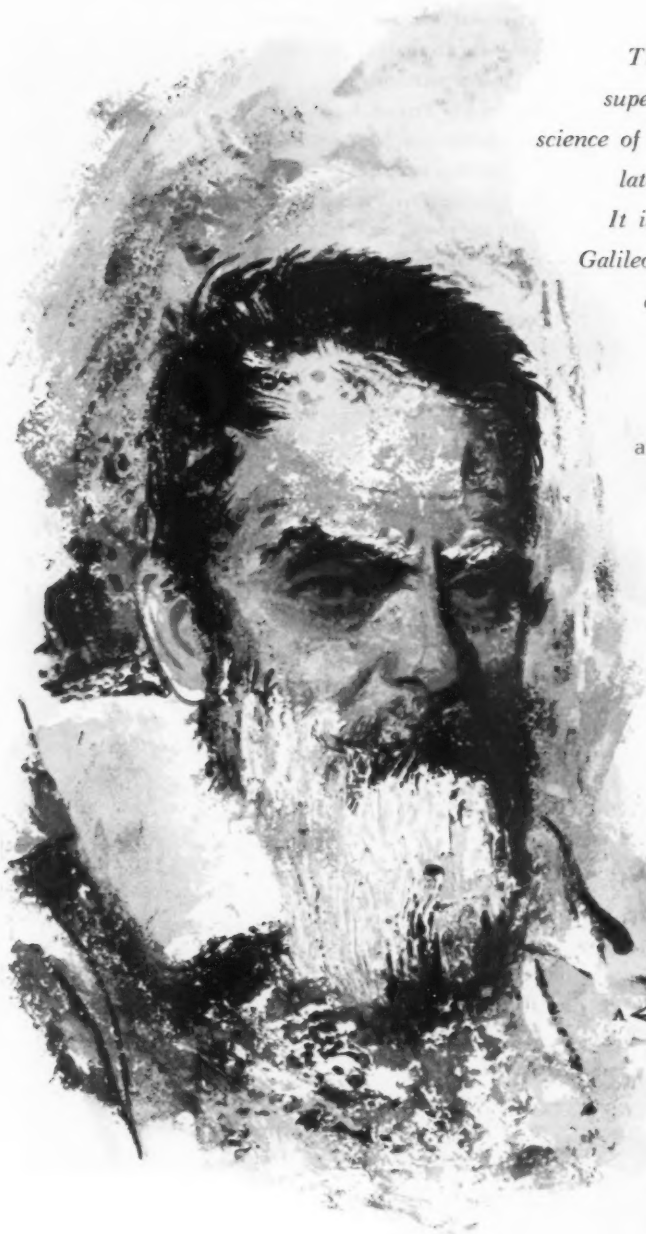
147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

Canadian Branch:

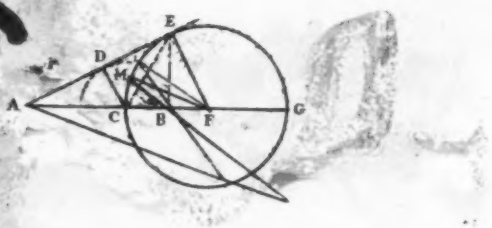
THE DUCON COMPANY, of CANADA, Ltd., 1151 Parrie St., BURLINGTON, ONTARIO, CANADA

THE QUALITY OF THINKING



The mind of Galileo—keenly analytical, superbly trained—led him to founding the science of experimental physics, which, centuries later, is revealing the mysteries of space. It is self-evident by his achievements that Galileo's mind reached a level of quality far above ordinary standards of excellence.

Within the same area of meaning, the quality of minds responsible for an engineering project can be evaluated only by results. When you check the record of Brown & Root's engineering through the years, the high quality of thinking reveals itself. Customer satisfaction from greater efficiency at lower costs has built a worldwide reputation for engineering and construction by Brown & Root.



"The knowledge of a single fact through a discovery of its causes prepares the mind to understand and ascertain other facts..."
Galileo

BROWN & ROOT, INC.

Engineers · Constructors • POST OFFICE BOX 3, HOUSTON 1, TEXAS • CABLE ADDRESS-BROWNBILT

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WHY SO MANY COME BACK FOR MORE...

Superior service in process construction is evidenced by repeat business from satisfied customers. Such happy evidence abounds at Procon.

Once a petroleum refiner or chemical processor has placed his trust in Procon, he develops the kind of confidence that brings him back again and again. Within a few years . . . or even months . . . a single-process-unit customer may be back with a contract to build an entire refinery.

In one recent case*, for example, contract followed contract from the same customer, for a total of eight . . . calling for 15 separate units to be erected at three different locations, and having a combined capacity of 300,000 BSD!

Three out of four contracts currently awarded Procon represent repeat business from satisfied customers . . . evidence of previous jobs well done.

**Name on request*

* '62 could be the year for you

*A SUBSTANTIAL INCREASE IN PROCESS CAPACITY will be needed by 1962, according to reliable estimates . . . NOW is the time to start your planning!

PROCON *Incorporated*

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DES PLAINES, ILLINOIS, U. S. A.

PROCON INTERNATIONAL S. A., CHICAGO, ILL., U. S. A.
PROCON (CANADA) LIMITED, TORONTO, CANADA
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PROCON PTY. LIMITED, SYDNEY, AUSTRALIA
PROCOFRANCE S.A.R.L., PARIS, FRANCE
PROCON LIMITADA, SAO PAULO, BRAZIL
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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

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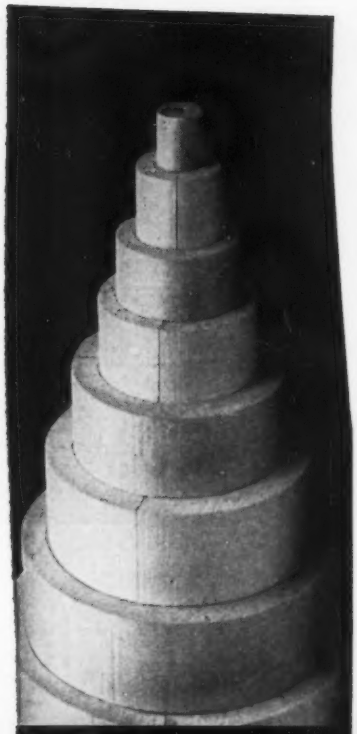


Drastic reduction of heat loss with **PABCO PRECISION-MOLDED CALTEMP** a Calcium Silicate Insulation

When vapors or liquids are conveyed or held at temperatures up to 1900° F.—when equipment is operated to high heat levels—Pabco Insulations cut heat losses to absolute minimums. "Precision-Molded" by a patented process, Pabco's Caltemp and 85% Magnesia pipe and block insulations control temperatures within close tolerances. For data on technical advantages, case histories, or engineering consultation, write...or call a Pabco insulation engineer.

INSULATION GUIDE

Temperature	Recommended Pabco Insulation		
to 550°	85% Magnesia pipe covering	block	cement
to 1200°	Caltemp pipe covering	block	cement
to 1500°	Prasco 15 C pipe covering	block	cement
to 1900°	Prasco 19 C	block	

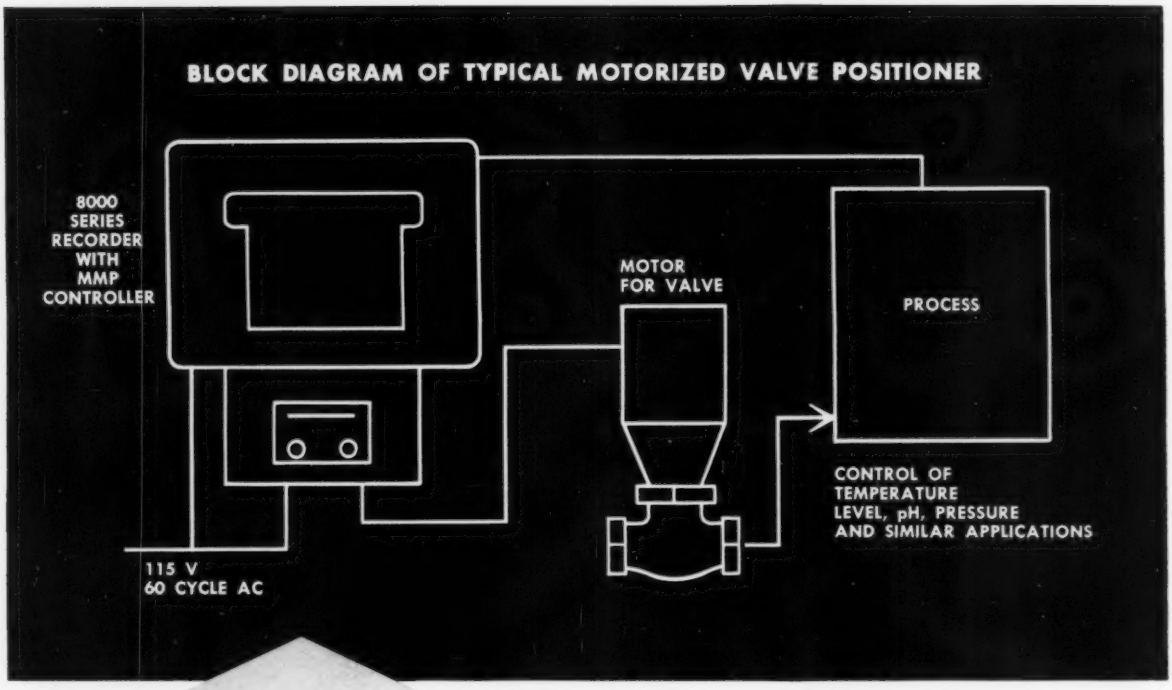
PABCO

INDUSTRIAL INSULATIONS DIVISION

Fibreboard Paper Products Corporation

San Francisco 19 • Chicago 54

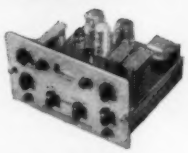
Houston 4 • New York 16 • Los Angeles


BLOCK DIAGRAM OF TYPICAL MOTORIZED VALVE POSITIONER
8000 SERIES RECORDER WITH MMP CONTROLLER
MOTOR FOR VALVE
PROCESS
CONTROL OF TEMPERATURE LEVEL, pH, PRESSURE AND SIMILAR APPLICATIONS
115 V 60 CYCLE AC

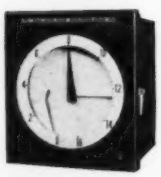
Wheelco . . . for flexibility in process control applications

Wheelco indicating-recording-controllers offer you utmost applications flexibility with top-quality process control instrumentation for measurement, indication, control and permanent recording of motion, flow, temperatures, speed, strain, hydrogen ion (pH) and other variables which can be resolved into electrical signals. Constant research, skilled engineering, precision manufacturing and efficient service are the qualities that have built Wheelco leadership . . . industry-wide applications have proved it . . . a nationwide network of trained service engineers insures it. Contact your nearby Wheelco sales and service personnel for complete information. They are at your disposal.

8000 SERIES single point indicating-recording-controllers and multipoint recorders. Bulletin F-8616-2, single point; F-7955-1, multi-point.



MM SERIES CONTROLLERS. Three function controllers; MMP position type, MMC current output type, and MMD duration type. Magnetic modulated. Adaptable to varied control needs. Bulletin F-8726, MMC; F-8727, MMP; F-8745, MMD.



2000 SERIES recorders and recorder-controllers. 4¾" width on 12" diameter chart. Bulletin F-8939.

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments Division

BARBER-COLMAN COMPANY

Dept. I, 1597 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. I, Toronto & Montreal. Export Agent: Ad. Auriema, Inc. N.Y.

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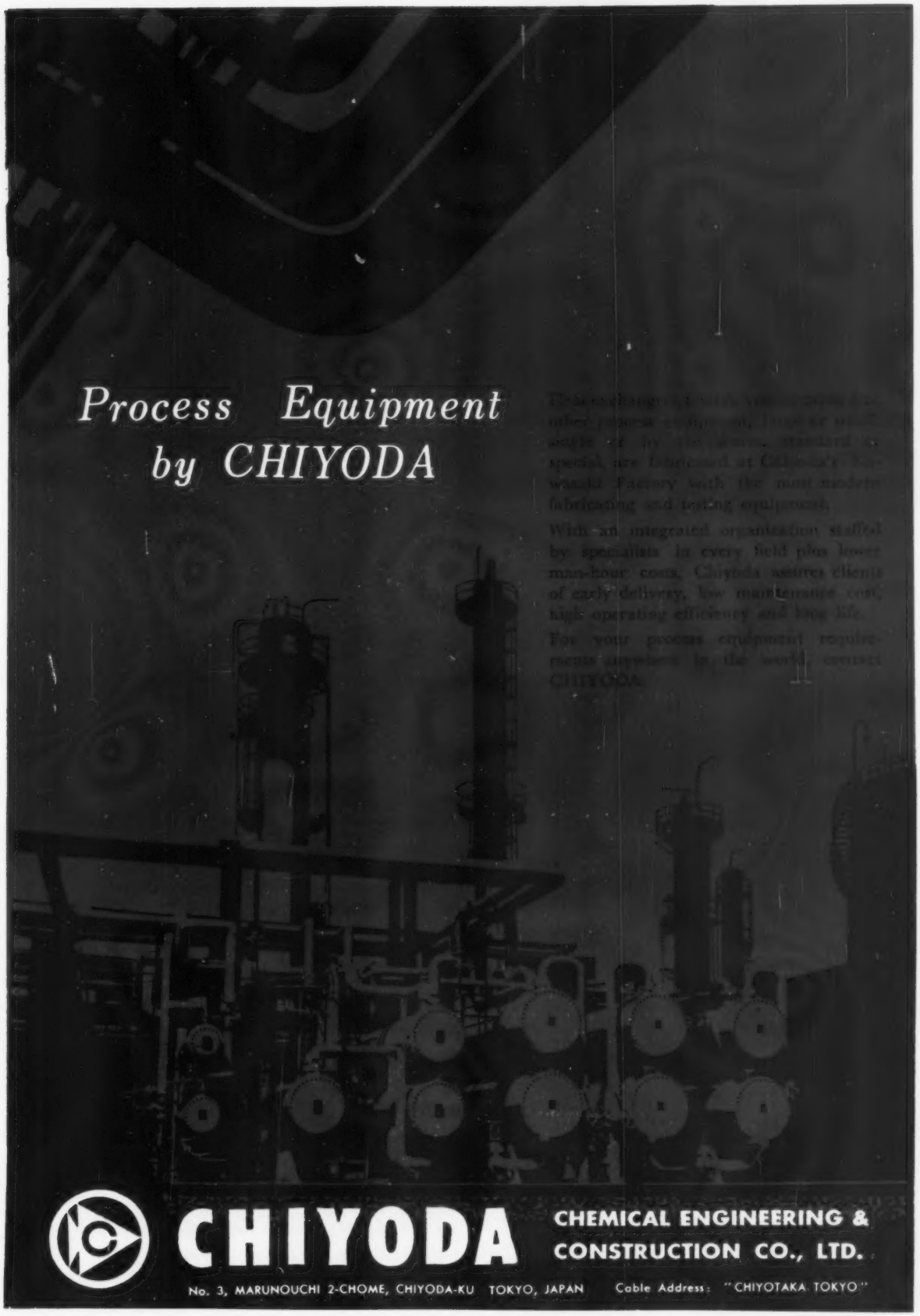

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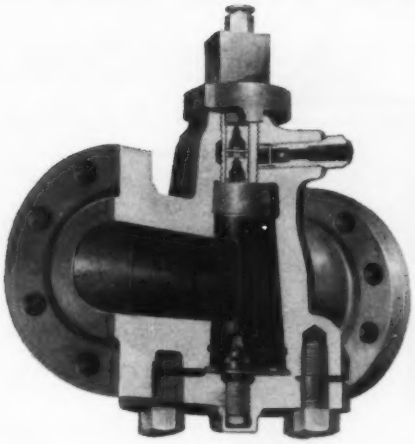
the idea:

Lubrication Makes Things Work Easier, Last Longer

The first recorded use of specially compounded lubricants (a cooked mixture of animal fats and calcium soap) was on chariot wheels in 1400 BC. Today, 34 centuries later, it is still common sense that *any* lubricated mechanism will work easier, last longer and cost less to use than a non-lubricated one.

the application:



How It Helps Give You A Better Valve

In the Rockwell-Nordstrom *lubricated* plug valve, metal-to-metal wear is practically eliminated by lubricant. And, the hydraulically compressed lubricant forms a powerful barrier against leakage around the plug. By jacking against the small end of the tapered plug to keep it free, lubricant also assures instant ¼-turn operation.

the benefits:

Longer Valve Life At Lower Cost... Leak Proof Sealing... Instant 1/4-Turn Operation... No Exposed Seating

The 6 million Rockwell-Nordstrom lubricated plug valves now used in a wide variety of industries are translating these benefits into dollars and cents savings day after day. Rockwell-Nordstrom is the most complete line of lubricated plug valves (sizes from ½" to 36"; pressures to 15,000 lb), lubricants and operating accessories. For *practical* help in solving your flow control problems, see your supplier or write: Rockwell Manufacturing Company, Dept. 95-J, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited. If you live outside the U. S. or Canada, write: Rockwell International, S.A., Geneva, Switzerland.

Lubrication Makes The Difference

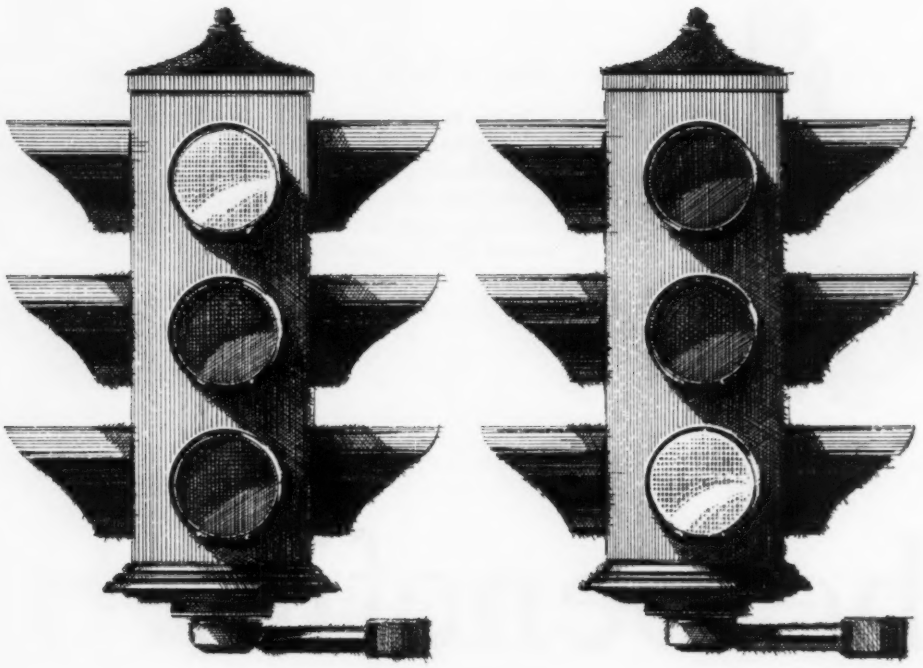
ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

For refining and natural gasoline plant services, Rockwell-Nordstrom Hypreseal valves stay leak proof, operate easily at highest pressures.

Which light is green?



Can you tell the real thing when you see it?

Pay attention to position. It's often important.

Take the question of caustic shipment. If you are situated on or near a navigable waterway . . . perhaps you should be receiving caustic by barge. It's low-cost transportation, and our studies reveal that a great many caustic users who should be taking advantage of it aren't doing so. May we help you pinpoint your position? We produce caustic at Geismar, Louisiana and Wyandotte, Michigan . . . ship it from either plant by barge or ocean tanker, truck or tank car. We know which should go where, and would like to put this knowledge to work for you. Call on us.

Wyandotte offers a number of chemicals for the petroleum industry, including materials for drilling muds, gas dehumidification, demulsifying, emulsifying, secondary recovery, water treatment, cementing, sweetening, and many other petroleum, refinery, and petrochemical applications. Get full details from your distributor, or write: *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Also Baton Rouge, Louisiana. Offices in principal cities.*

ANSWER: You can be pretty sure that the bottom light is green. Most are . . . but don't bet your life on it!

* * * * *

WYANDOTTE CHEMICALS

MICHIGAN ALKALI DIVISION

Pacing progress with creative chemistry®

COUNTRY-WIDE TESTS PROVE HOW TOTCO CONTINUOUS END-POINT ANALYZER CUTS CONTROL COSTS

...INCREASES YIELD *In major refineries from the East Coast to the West, the new Totco continuous End-Point Analyzer has demonstrated its ability to provide better control over product quality and yield. It quickly pays for itself and steps up profits.* ■ *This sensitive instrument continuously indicates the Engler End Point of a hydrocarbon stock or commodity in an operating range of 200° F. to 700° F. It delivers reproducibility within ±1°F., with results that correlate with ASTM D86 or ASTM D158. And its continuous analysis cuts the usual delays between quality change and compensating plant control... eliminates the time lag of batch analyzers or conventional laboratory tests.* ■ *Write or call today for further information. Request Bulletin 5900-11.*

CASE HISTORY #1

Major Eastern Refinery

Use of the TOTCO End-Point Analyzer enabled this refiner to step up end-point specifications of reformer feed stock by 10°F with safety. Result: increased yield and a saving of over $200 a day. On the basis of this test, six additional Totco units were ordered!

CASE HISTORY #2

Major West Coast Refinery

Both TOTCO's End-Point Analyzer and Initial Boiling Point Analyzer were used here on a narrow-cut solvent. It was found that the analyzers kept yield on grade better than 99% of the time! Previous average with laboratory control was 90%.

CASE HISTORY #3

Major Mid-West Refinery

In this test, the TOTCO End-Point Analyzer was mounted in a trailer and used on a crude still to control first-cut products on stream. So successful was the test that the company ordered two additional Analyzers for use at other refineries.

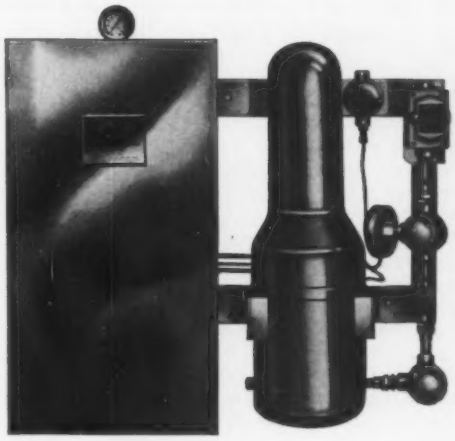
CASE HISTORY #4

Major Western Refinery

Demonstrating the versatility of the TOTCO End-Point Analyzer was this test where it was used to control the cut on heavy naptha. The test was a money-saving success, and the firm has since ordered additional units.

TOTCO CONTINUOUS INITIAL BOILING POINT ANALYZER

Totco also manufactures an Initial Boiling Point Analyzer. Write for Bulletin 1259-11 giving details and operating data.



TOTCO

TECHNICAL OIL TOOL CORPORATION

1057 North La Brea Avenue, Los Angeles 38, California • OLdfield 4-1763

Manufacturers of Precision Instruments since 1929

HELPFUL WATER CONDITIONING DATA FROM BETZ

PRETREATMENT FOR EFFECTIVE

■ Rapid film formation by pretreatment can vastly improve cooling water corrosion control. The benefits are many and the added costs are negligible.

THE ADVANCES MADE in the control of corrosion in open recirculating cooling water systems over the past decade have been phenomenal. The Dianodic methods[1] for corrosion control are capable of decreasing the corrosion rate of steel to 1 mil per year or less with the pitting function totally prevented or definitely stifled. Excellent protection is secured with treatment concentrations generally in the range of 30 to 100 ppm, depending on operating conditions and water characteristics. Because steel can be protected economically many of the newly designed plants include all-steel heat exchangers in place of the more costly and more commonly used Admiralty tubed heat exchangers. The cost of all-steel heat exchangers is approximately 60% of the cost of heat exchangers constructed with Admiralty tubes. Under these conditions the capital investment for a new plant is considerably less when steel is used.

However, the design engineer should be cognizant of all factors that have a bearing on the service life of steel tubed heat exchangers. The experiences of one plant designed with all-steel heat exchangers will illustrate several of the precautions that are necessary if the expected service life is to be secured. Shortly after this new plant went into operation, it was found that pressure drops across many of the heat exchangers were greater than anticipated. Examinations of the heat exchangers revealed that heavy tuberculation was present in the steel tubes and in the water boxes. Some of the tubes were blocked with tubercules that had broken free from other locations. It was evident that the handling of the bundles during construction of the plant permitted corrosion to start. The pressure of other work attendant with start-up did not allow sufficient time for initial cleaning of the heat exchangers for removal of debris, grease, and corrosion products that had accumulated during construction. No pretreatment of the heat exchangers was employed and the intermittent operation of the system permitted frequent periods of inadequate inhibitor concentrations so that corrosion progressed at a rapid rate.

A marked difference in the care of handling steel tubed heat exchangers compared to handling Admiralty tubed heat exchangers is evident from this and similar experiences. The corrosion rate of steel under these adverse conditions is many times greater than the corrosion of Admiralty and the quantity of corrosion products produced is proportionally greater. When steel tubed heat exchangers are employed, it is essential that care be exercised in the initial handling of the bundles to avoid corrosion during construction and initial start-up. It is mandatory to clean steel bundles and to pretreat them to render the metal surfaces passive.

Pretreatment

Most methods of corrosion control are based on forming a film that acts as a barrier to stifle corrosion. The rate at which the film or barrier forms will largely determine the effectiveness of the treatment. Materials that do not form films rapidly will permit corrosion to take place and the result will be incomplete film formation and continued corrosion. The rate at which the film forms is related to the inhibitor concentration.

The function of pretreatment is primarily to permit rapid film formation to stifle the corrosion reaction immediately by formation of a uniform impervious film. Under these conditions the low treatment levels will maintain the film intact and avoid the accumulation of corrosion products.

Reference to Figure 1, Curve A, shows the high initial corrosion rate of steel when exposed to Philadelphia tap water, fortified with 500 ppm of chloride, and at a temperature of 120 F. The application of 30 ppm of Zinc-Dianodic markedly decreases the rate of corrosion (to less than 1.5 mils per year at the end of 3 days). However, if the steel is first pretreated for rapid film formation with a treatment concentration of 500 ppm of Zinc-Dianodic for only 4 hours and thereafter treated with 30 ppm of Zinc-Dianodic an even greater reduction in the initial corrosion rate as well as the over-all corrosion rate results, as shown by Curve C.

The data contained in Figure 2, demonstrate the superior qualities of the film formed by 500 ppm of Zinc-Dianodic compared to 5000 ppm of chromate. Pretreatment with 5000 ppm of chromate for 2 hours permitted a 50% reduction in weight loss and a corresponding reduction in the amount of corrosion products that accumulate.

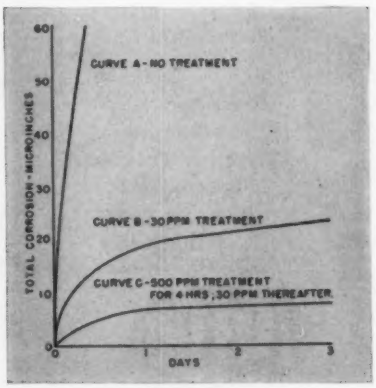


Figure 1

However, pretreatment with 500 ppm of Zinc-Dianodic for 2 hours permitted more than an 80% reduction in weight loss and a negligible accumulation of corrosion products.

The low treatment levels normally used for corrosion control in open recirculating systems should be viewed as the quantities required to maintain the film intact and to heal the slight breaks that may occur from minor variations in environment. Whenever any serious changes in environment occur that cause destruction of the film, corrosion products can accumulate before the film is re-established by the low treatment levels. Under these conditions, in order to secure maximum corrosion protection and to minimize accumulation of corrosion products, treatment levels should be increased to re-establish the protective film as rapidly as possible.

Pretreatment of steel heat exchangers is required . . .

. . . for all new bundles
. . . whenever the exchangers are acid cleaned
. . . whenever low pH is encountered
. . . whenever serious process leakage occurs
. . . immediately following start-up after inspections.

Care of Steel Exchangers

Initial Treatment

The care of new steel heat exchangers should start with the writing of the

[1] Dianodic is a registered trademark. The methods are covered by U. S. Patents 2,711,391; 2,900,222; 2,872,281; 2,848,299.

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specifications. The design engineer should include as part of the specifications, a requirement that the units be delivered free of debris, grease and other foreign matter that may initiate corrosion, and that the units be protected from the weather during transit and prior to installation. As soon as possible after installation, and prior to placing the system in full operation, pretreatment should be applied to the circulating water to permit rapid film formation. A procedure of this type will avoid excessive pressure drops and assure maximum protection of the units as well as materially aid in achieving the anticipated service life of an all-steel system.

Other Factors

Once the film is properly formed, the normal treatment levels will serve to maintain the film and prevent corrosion under normal operating conditions. However, there are a number of factors that can destroy the film to such a degree that higher than normal treatment levels will be required to re-establish the film rapidly. For example, when an individual heat exchanger is acid cleaned, the film will be completely destroyed. Acid cleaning will leave the steel surfaces in a very active state and the initial corrosion rate will be very high. The normal treatment levels usually will not permit sufficiently rapid re-establishment of the film. Therefore, following acid cleaning and flushing, the unit should be pretreated.

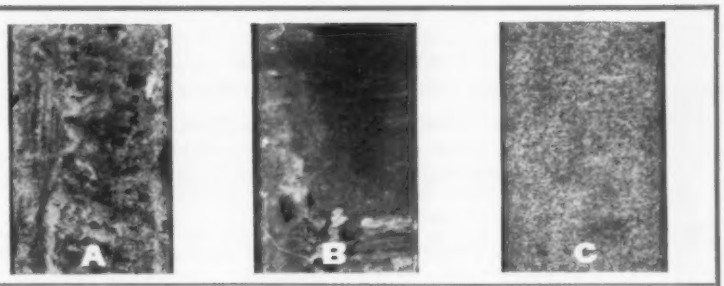
The modern day corrosion inhibitors function best in a pH range of 6.0-7.0. This same pH range permits maximum protection to tower wood and is usually the pH range required to avoid calcium deposits. Therefore, acid treatment of the circulating water to control pH is a common practice. In the great majority of these systems excellent control of pH is maintained. On occasion, however, low pH values may develop. If low pH is permitted for any extended period of time, partial or complete destruction of the protective film may occur. When this occurs, treatment levels should be increased to re-establish the film as soon as possible.

In other systems, process leakage may introduce hydrogen sulfide and mercaptans. This type contamination will have an adverse effect on most films. Also, leakage of this type usually produces a drop in pH as well. Until such time that the leakage can be corrected the system should be blown down heavily. If it is established that a particular heat exchanger is a chronic offender, it should be equipped with blowdown facilities so that as much of the blowdown as possible is taken from the offending heat exchanger. Following correction of the leak, treatment levels should be increased to rapidly re-establish the film.

The periodic inspections required for most systems will produce conditions during start-up that may increase the initial corrosion rate. For example, brushing or manual cleaning of the water boxes or other parts of the heat exchanger may partially or totally remove the protective film. Debris and migratory corrosion products may settle at various points in the system. These and many other factors will create conditions conducive to corrosion. Pretreatment by the use of higher than normal treatment levels during start-up will assure rapid repair of the protective film and minimize the accumulation of corrosion products.

The precautions outlined above will be instrumental in achieving maximum service life from all-steel heat exchanger systems.

CORROSION CONTROL



Specimen	Pretreatment (2 hrs.)	Loss-mgs. (24 hrs.)
A	None	36
B	5000 ppm chromate	18
C	500 ppm Zn-Dianodic	6

Conditions—Philadelphia tap water fortified with 500 ppm chloride. Temperature 120 F. 24 hour exposure in 8 ppm of Zinc-Dianodic after pretreatment as indicated.

Figure 2

General Application

While much attention has been focused on the use of pretreatment for all-steel systems because of the higher corrosion rates that can occur, the principles of pretreatment have application to and will prove beneficial for cooling water systems in general. It is true that the initial corrosion rates for Admiralty tubes or tubes of copper alloys in general are materially lower than for steel, and therefore the effects of these less voluminous corrosion products are not as pronounced. However, where Admiralty tubed heat exchangers are employed the systems are bimetallic since the shells and water boxes are constructed of steel. While the Admiralty heat exchanger tubes are not adversely affected, the steel components of these units do undergo an initially high corrosion rate and produce voluminous corrosion products that interfere with proper and complete film formation. The application of the principles of pretreatment for rapid film formation, followed by the use of normal treatment levels for film maintenance will prove of benefit in minimizing corrosion of the steel parts of the system. In general, improved heat transfer, longer service life and less plant maintenance are the benefits that will be secured.

The Dianodic methods developed by Betz are the most effective corrosion control treatments for recirculating cooling water systems. Their effectiveness is due to the ability to form protective films rapidly and to maintain these films with relatively low treatment levels. The Betz Engineer in your area will be pleased to discuss corrosion control and the application of pretreatment to handle your cooling water problems. Why not contact him *today?*

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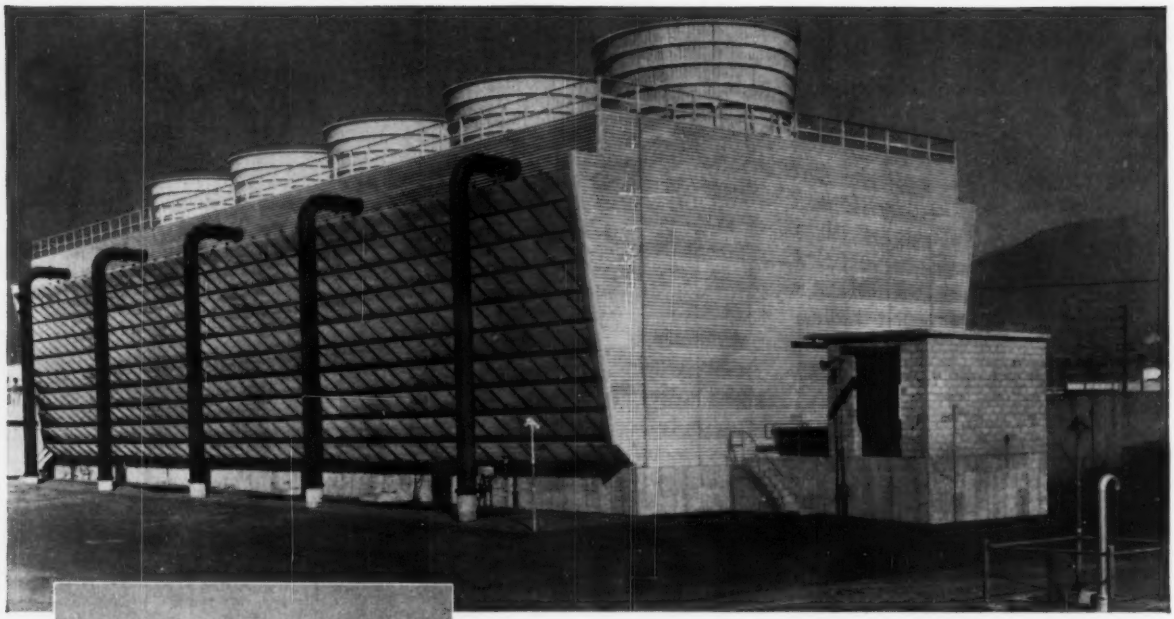

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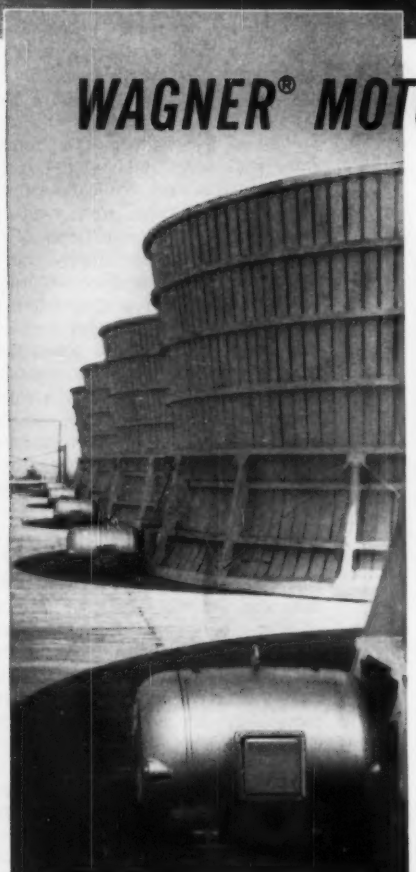

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What about your requirements for motor drives that must operate under adverse conditions? Versatile Wagner Totally-Enclosed Motors can meet them, whatever the application. They are available in standard ratings through 500 hp. Call your nearby Wagner Sales Engineer for full details, or write for Bulletins MU-224 and MU-230.

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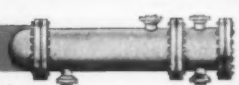

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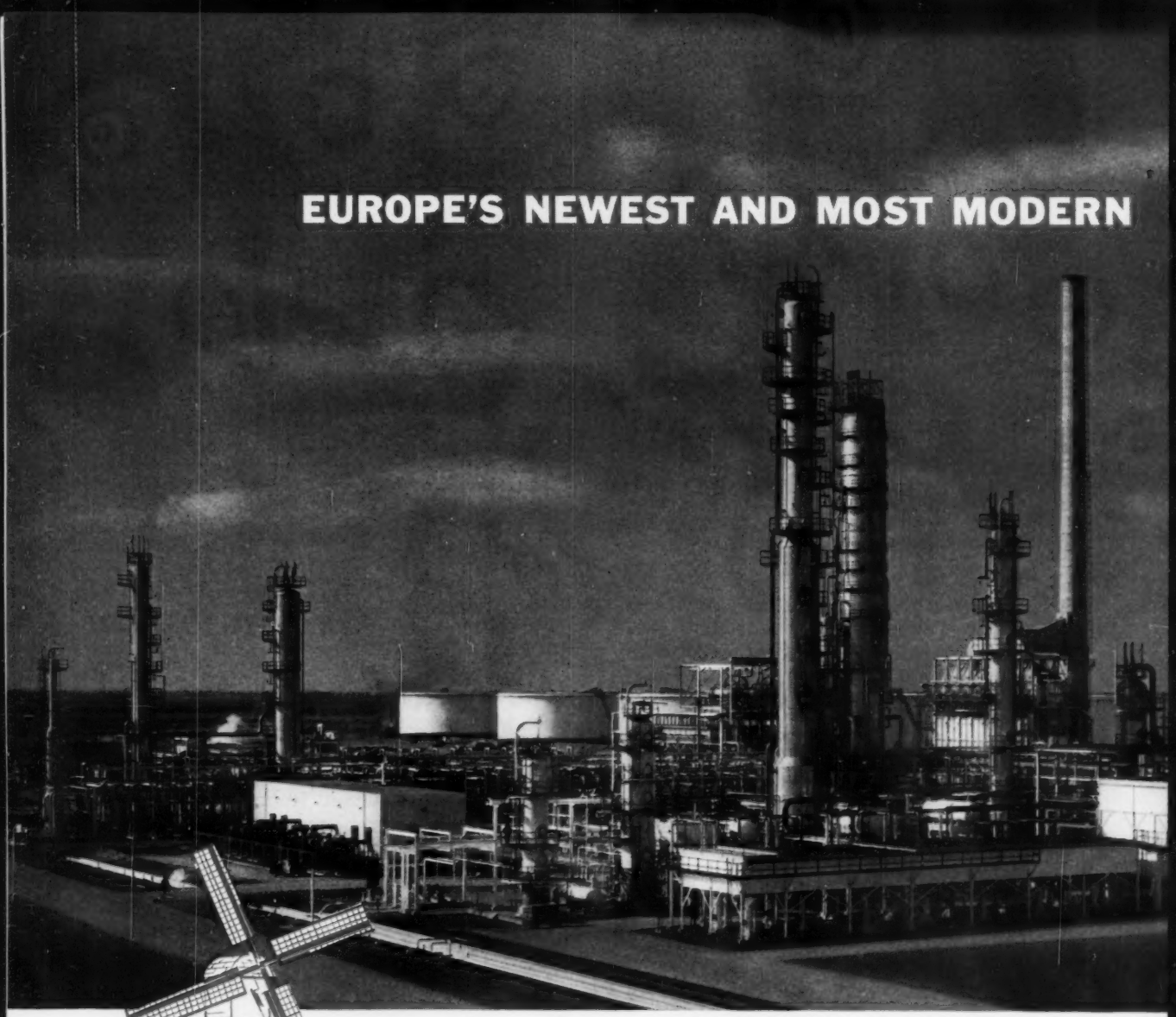


From Polder to Production in 24 Months

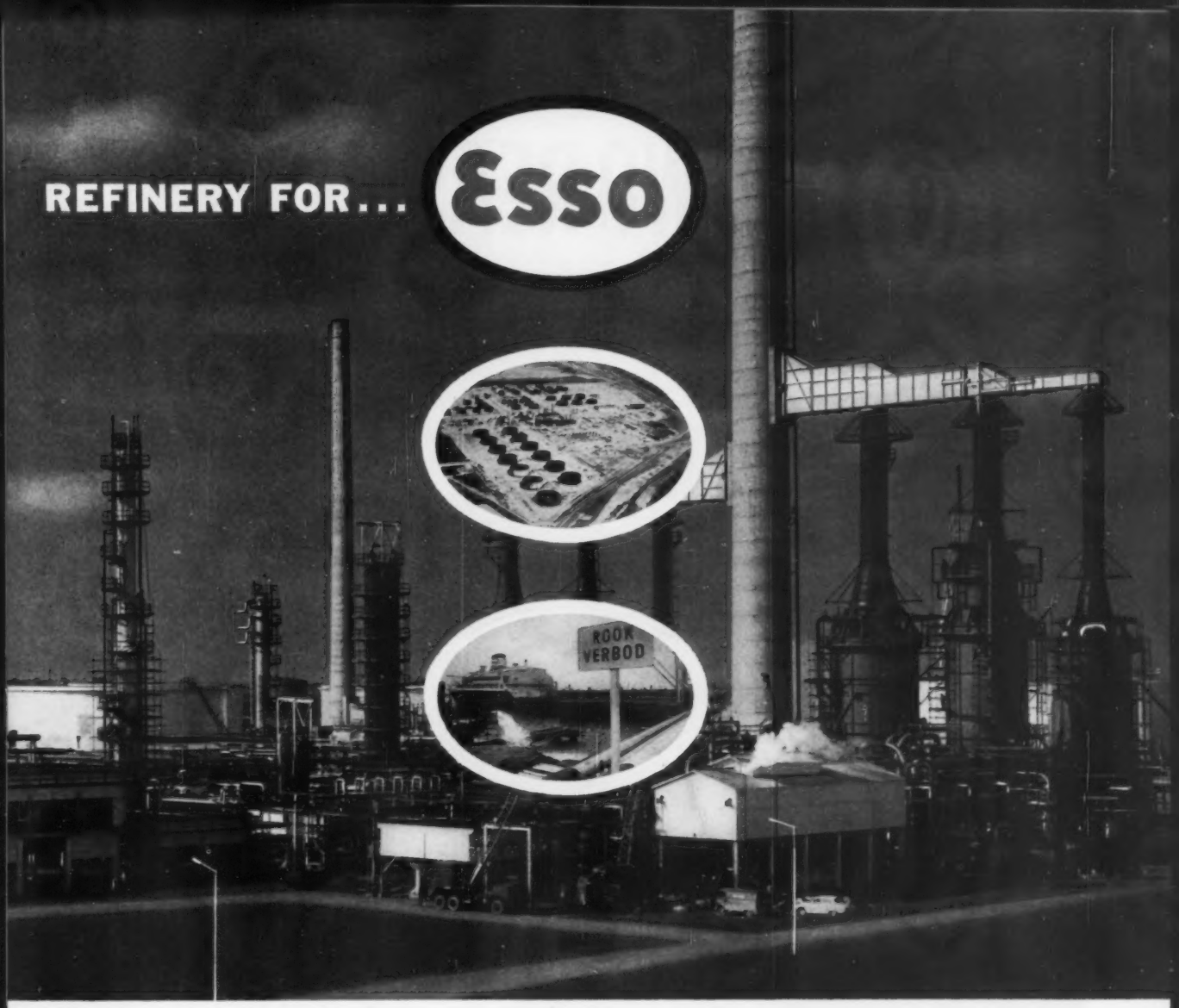
In a country which has long been accustomed to engineering miracles, Esso Nederland's new "grass-roots" refinery in Rotterdam is being acclaimed a technical and logistical feat of the first rank. For here, on a "site" that a scant two years ago was a polder barely higher than the bordering River Maas, Badger N.V. has engineered and built a mammoth processing complex covering some 275 acres.

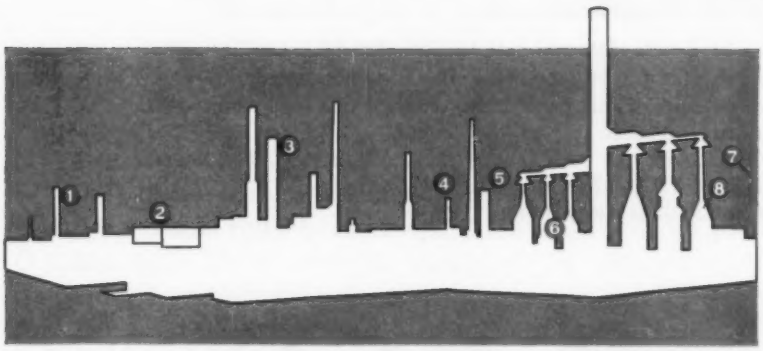
The 100,000 bpsd refinery is the largest in Europe which is completely air cooled, completely electronically controlled and equipped with fully automatic product loading facilities. At one time 2600 men, drawn by Badger from a dozen different countries, were directly engaged in its construction. This army of specialists handled over 30,000 tons of steel . . . 10,000 tons of cement . . . miles of electrical cable, timber and pipe.

The work started, as most Dutch construction projects start, with "creating" land — 10 million yards of fill, supplied by the municipality of Rotterdam, were laced by more than 2000 piles, 80 feet long. On this underpinning Badger crews procured and erected the process units, storage tanks, waterfront and offsite facilities.

This refinery is another example of the reason why Badger and its overseas affiliates have established a world-wide reputation for making tough projects look easy. Whether you are thinking in terms of a small unit or major plant, it's the type of service you deserve. Please write or call for complete information on Badger services.

REFINERY FOR... ESSO





The main process units of the Esso Nederland Refinery consist of ❶ Naphtha Stabilizer ❷ Crude Storage ❸ Crude Distillation ❹ Diesel Oil Hydrofiner ❺ Steam Plant and Water Treating Plant ❻ Powerformer ❼ Tanker, barge, rail and truck loading facilities ❽ Copper Chloride Treater. Blending Units are at right out of picture.

Waterfront facilities for the refinery cover 2260 meters and include two piers each capable of simultaneously handling a supertanker of up to 50,000 dwt.

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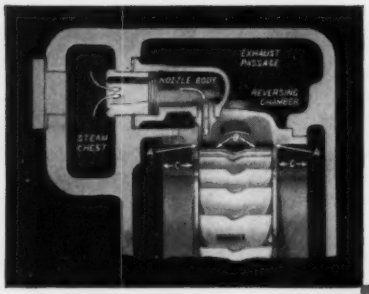
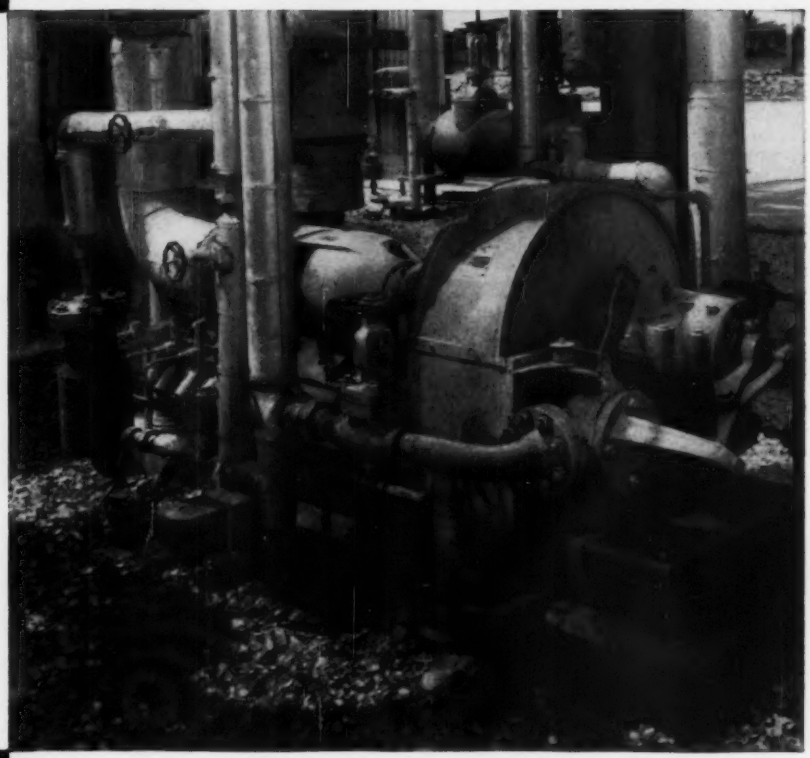


TWO REASONS WHY

this turbine seldom sees down time



1 ***Generous wheel clearances:*** AA —rim clearance, B—blade clearance, CC —side clearance. Blades can't foul as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large (about one inch) that end-play from excessive external thrust cannot damage wheel.

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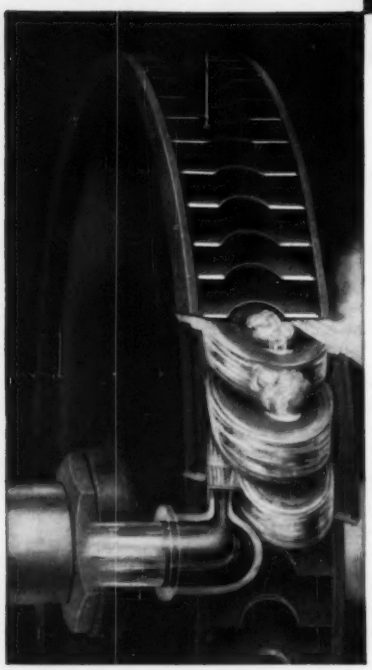

To prevent costly shutdowns for repairs, Terry builds bonus reliability into each solid-wheel turbine. Two of the ways in which this is accomplished are shown in the diagrams at the left.

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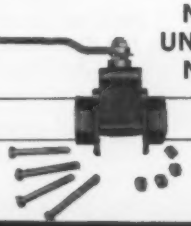

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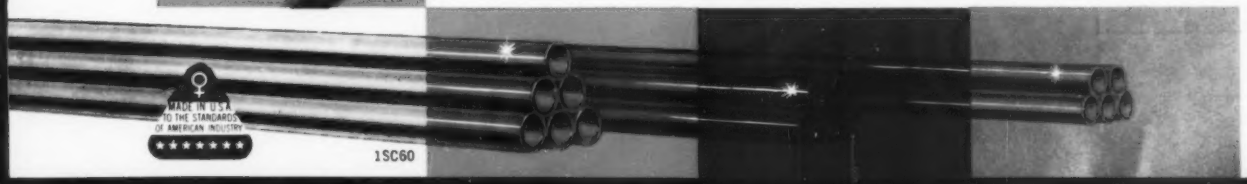

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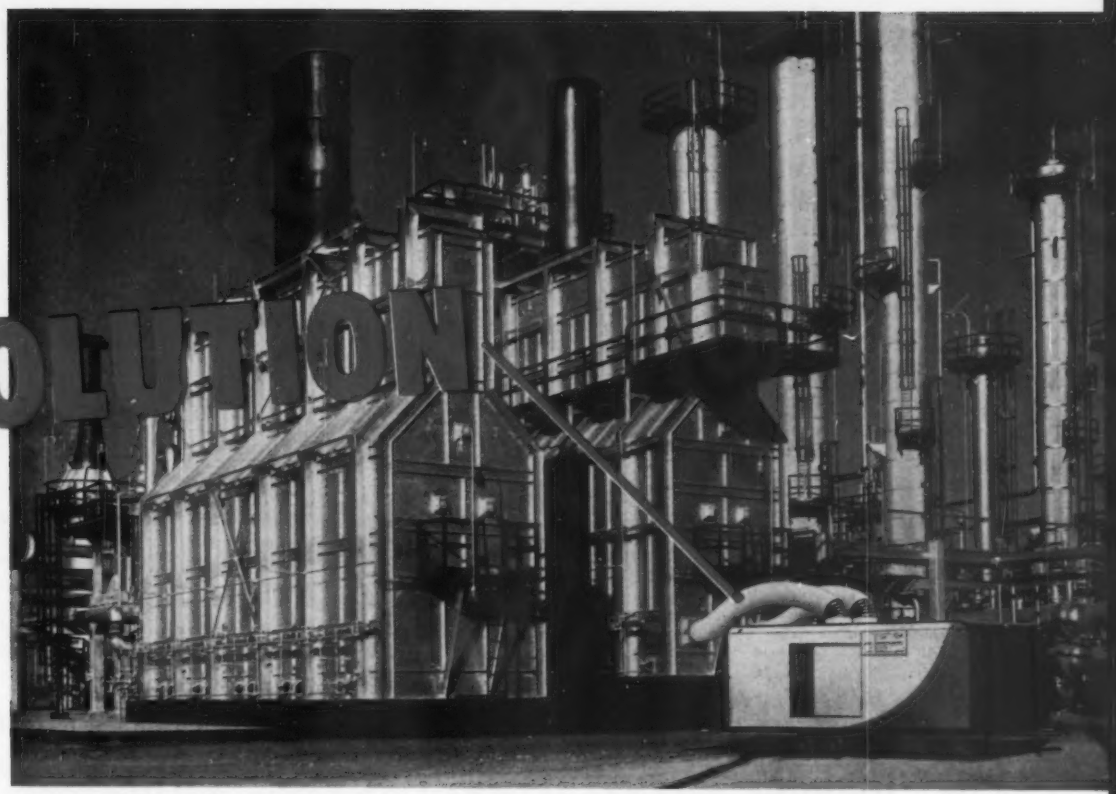

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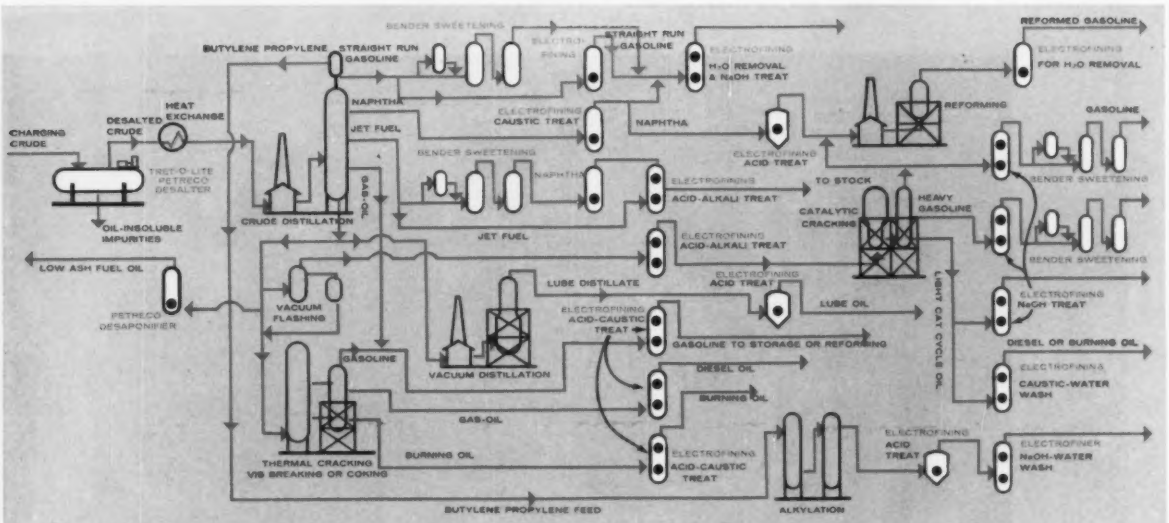

This flow diagram shows how Petreco equipment can be applied to various refining problems to improve product quality at minimum investment. (1) PETRECO* Electric Desalting or TRET-O-LITE* Chemical Desalting units purify charging crude. (2) ELECTROFINING* Precipitators perform a variety of distillate treating operations. (3) PETRECO-BENDER Catalytic Sweetening Process treats distillates in the No. 2 fuel-kerosine-gasoline range to provide a sweet, non-corrosive product. (4) PETRECO Lube-Acid Treating provides continuous, automatically-controlled, acid treatment for lubricating oils and similar stocks in a closed non-air-polluting system. (5) PETRECO Desaponification Process removes about 85% of the ash-forming constituents from fuel stocks, enabling them to be marketed advantageously or used as charging stock for cracking.

Other Petreco purification processes available but not shown in the diagram include units for dehydration and sediment separation.

Impurity removal is much too important to be provided for as an afterthought...

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Although PETRECO processing equipment can be installed at any time, the most effective installations are those provided for in *the refinery's initial planning stage*. When desalting and purification units are planned as integral parts of the basic refinery design, impurity removal and product treatment can be accomplished more efficiently. Space can be better utilized, pipe and pump requirements can be reduced, fewer and smaller vessels can be used, and construction costs held at minimum.

Also, planning purification and treating installations at the preliminary design stage allows adequate time to determine exact equipment needs. The Petreco engineering staff is always available for consultation. Call on Petreco for help with *any* purification or treating problem, whether it's on the drawing board or in an operating refinery.

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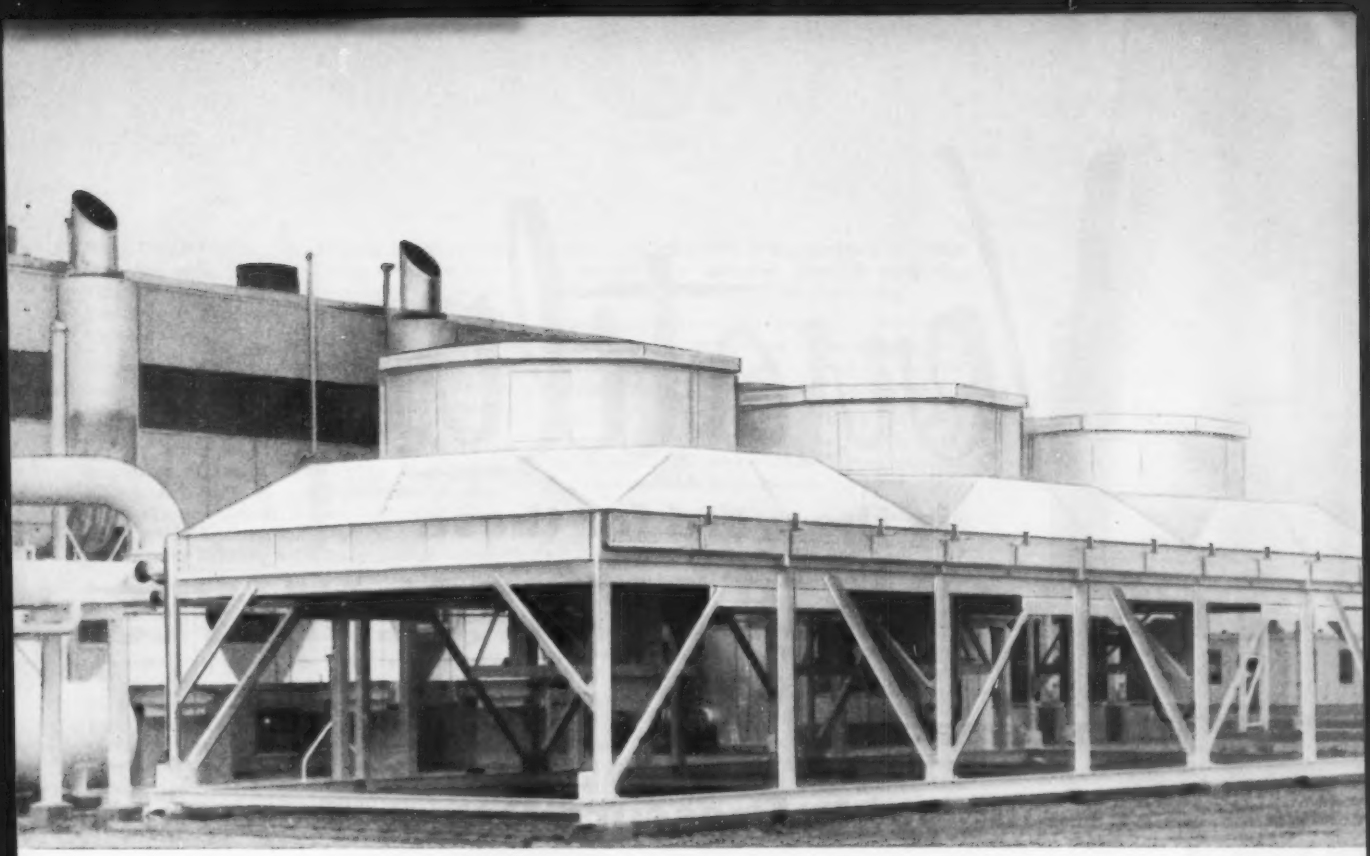


Giant compressor and generator engines are cooled by 26 TRANE Fluid Coolers at 6 Trans-Canada stations. Both horizontal and vertical air discharge types are used.

Trans-Canada, longest gas pipeline in the world, chooses Trane Fluid Coolers to cool engine water!

The Trans-Canada Pipeline System—2,294 miles long—provides market outlets for reserves of Alberta natural gas, serves Western Canada, and the great industrial areas of Eastern Canada.

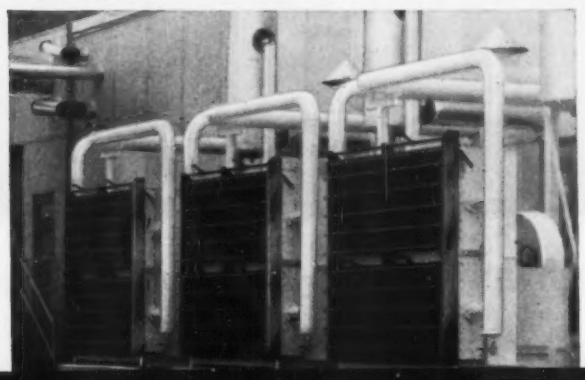
Because this pipeline passes through country where winter temperatures are very low, it was necessary to install engine jacket water cooling equipment that would function at 40 degrees below zero!

Trans-Canada chose TRANE Fluid Coolers for this important job. 26 TRANE units serve the initial six compressor stations. Air cooling was considered essential—and TRANE Fluid Coolers have shown that they can operate efficiently under all weather conditions.

More and more transmission companies are turning to TRANE for cooling equipment. Many have reported simplified maintenance, a minimum of adjustment problems. And engineers *know* that they can depend upon the accuracy and completeness of TRANE capacity ratings—tested in the industry's most complete laboratory, where as many as 90 different temperature readings are taken across the face of a heat transfer section!

When you have a fluid cooling problem, turn to TRANE! Just call your nearby TRANE Sales Office—or write TRANE, La Crosse, Wisconsin.

Small TRANE Horizontal Air Discharge Coolers cool the engines used to drive the 250-kilowatt generators (three per station) which supply electrical power on stations not served by a utility.



For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES

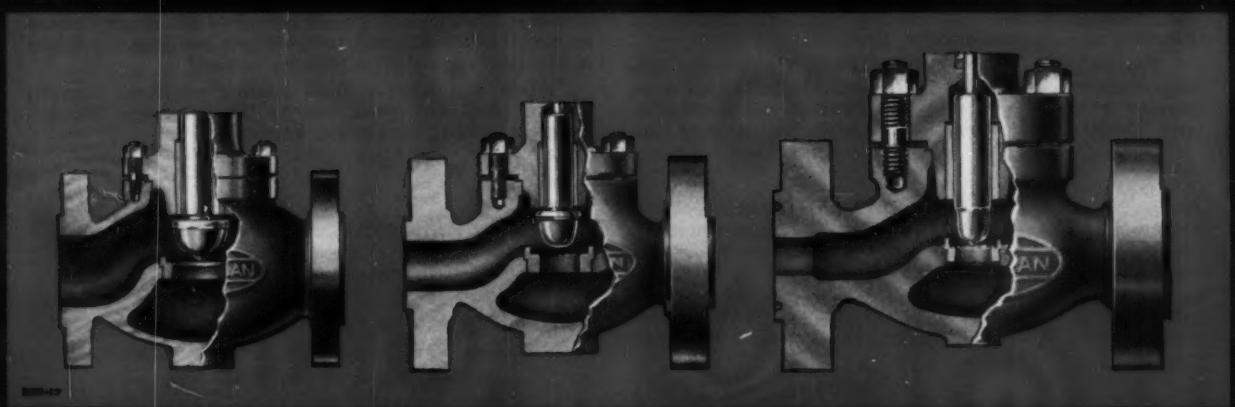
Versatility

is the word for these

SINGLE SEATED CONTROL VALVES

- **High Capacity**
- **High Allowable Pressure Drops**
- **Wide Selection of Reduced Capacity Trim**

The new line of Mason-Neilan 20000 Series Control Valves provides the most versatile single seat design available. They have an unusual combination of premium features that suit them for a wide range of applications, including viscous fluids and slurries.



Two inch, 600 lb. body with full capacity plug Two inch, 1500 lb. body with full capacity plug Two inch, 2500 lb. body with full capacity plug

See Masoneilan Exhibit at the

High Capacity . . . top guiding, unrestricted seat ring area, body and plug contours provide greater capacity than most top-and-bottom-guided double seated valves of comparable sizes.

High Pressures and Pressure Drops . . . high capacity is attained with minimum seat ring areas, resulting in less unbalance force, permitting higher pressure drops. Heavy guiding throughout full stroke results in a minimum of unsupported plug length and allows high pressure and high pressure drop applications without lateral vibration. Generous guide surfaces and large plug stems are sized in accordance with body rating.

Soft Seat Trim . . . available in Teflon and Buna-N. Suitable for static pressures and pressure drops up to 500 psi.

Wide Selection of Reduced Capacity Trim . . . for those applications where velocity due to high drop is a consideration (or where future requirements for larger capacity are a factor) a wide selection of reduced capacity trim is available — and interchangeable in comparable valve sizes and ratings (see table). The proper relationship between stroke and trim size is maintained in order to provide the strongest possible plug tip, particularly in hard, brittle materials.

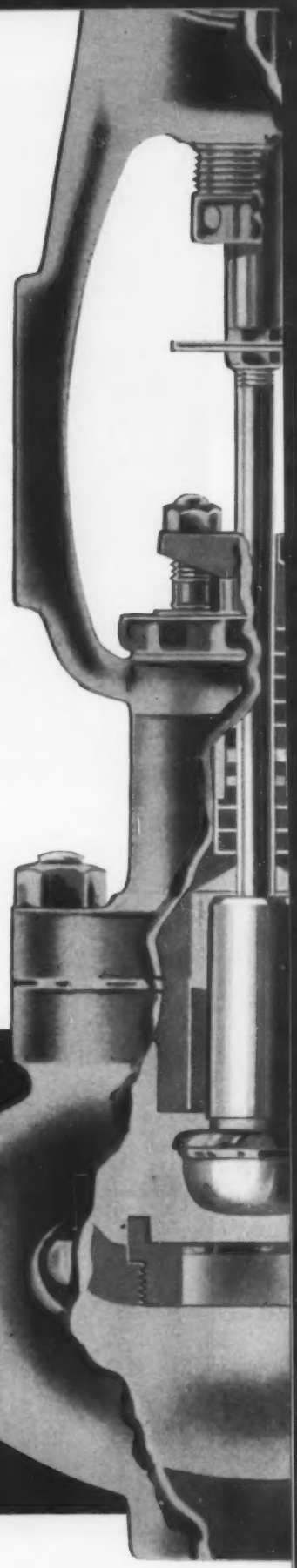
Wide Selection of Materials . . . the design of body and plug permits the use of suitable special materials to meet severe operating conditions.

Suitable for Slurries . . . body and plug contours (plus the fact that no bottom guiding is required) make these valves suitable for viscous fluids and slurries.

Welding Ends Available . . . the solid-cast body allows the use of welding ends. The removable bolted bonnet permits easy (only one joint to break) inspection or cleaning with valve in the line.

Actuators Sized to Body Rating . . . the standard spring-diaphragm (direct or reverse) actuator is sized according to body rating, thus minimizing requirements for oversize actuators in severe applications.

These 20000 Series are economical to buy and operate. Look into these many advantages; send for complete details or contact your local Mason-Neilan representative.



MASONEILAN

MASON-NEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASS., U.S.A.

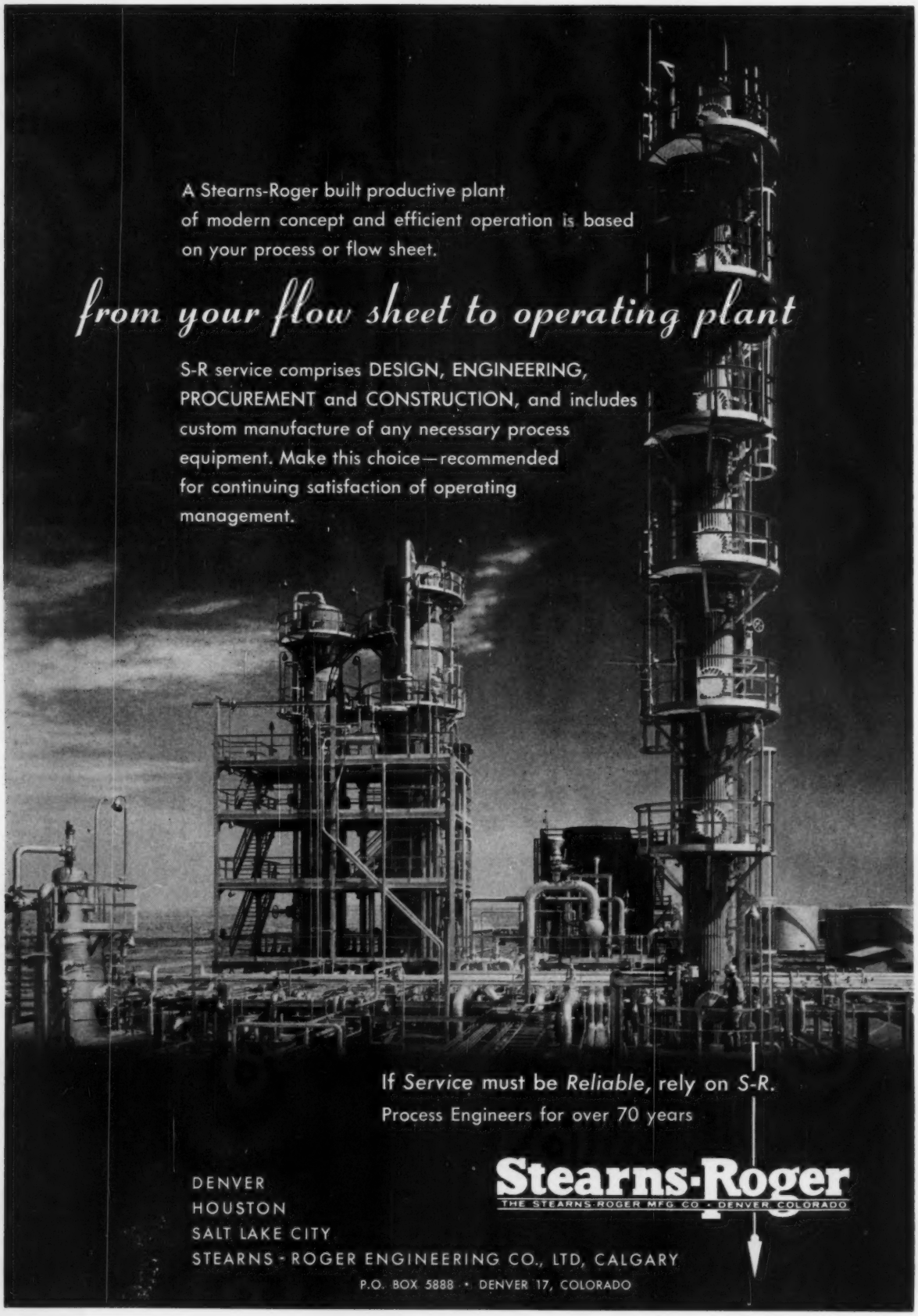
Sales Offices or Distributors in Principal Cities in United States and Abroad

In Canada: Worthington (Canada) Ltd., Mason-Neilan Division

Available Cv Ratings

Valve Size	NOMINAL TRIM SIZE											
	¼"	⅜"	½"	¾"	1"	1½"	2"	3"	4"	6"	8"	10"
¾"	1.5	3.4	5.2	8								
1"	1.5	3.4	5.2	10.8	12							
1½"	1.5	3.4	5.2	12	14	25						
2"	1.5	3.4	5.2	12	18	25	46					
3"				12		25	46	110				
4"						25	46	110	195			
6"							46	110	195	400		
8"								110	195	400	640	
10"									195	400	640	1000

I.S.A. Show, Booth 1412


A Stearns-Roger built productive plant
of modern concept and efficient operation is based
on your process or flow sheet.
from your flow sheet to operating plant
S-R service comprises DESIGN, ENGINEERING,
PROCUREMENT and CONSTRUCTION, and includes
custom manufacture of any necessary process
equipment. Make this choice—recommended
for continuing satisfaction of operating
management.
If Service must be Reliable, rely on S-R.
Process Engineers for over 70 years
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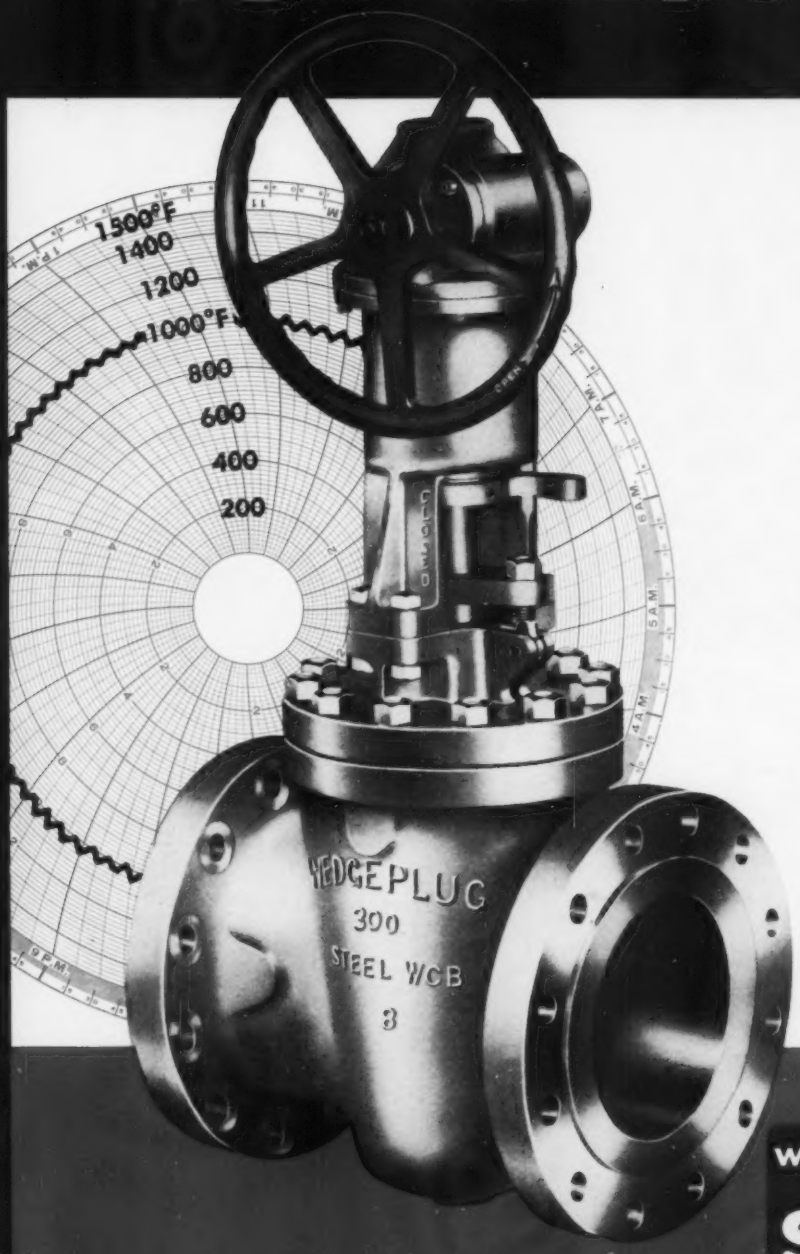
Positive Shut-off at High Temperatures



WEDGEPLUGS
give positive control without lubricants

Wedgeplugs are proven performers on coking and catalyst lines:

No lubricants required for absolute control. Plug lifts, turns and reseats in one quick, easy operation.

Non sticking. Self-adjusting operator compensates for variable temperature. Will not stick on coking services.

Protected seats prevent valve-killing erosion of dry and fluid catalysts—a constant problem and expense when gate valves are used. With Wedgeplugs, you eliminate this extra maintenance cost.

Wedgeplugs are proven performers on such services as hydrocarbon vapors at 900°F and 600 psi; fluid catalysts at 1125°F and 225 psi; and hydrogen at 900°F and 300 psi. Wedgeplug valves can be supplied in alloy steels as service demands.

Non-lubricated plug valves • Cast iron, malleable and ductile iron pipe fittings • Bronze, cast iron, ductile iron, cast and forged steel valves

IT PAYS TO BUY QUALITY

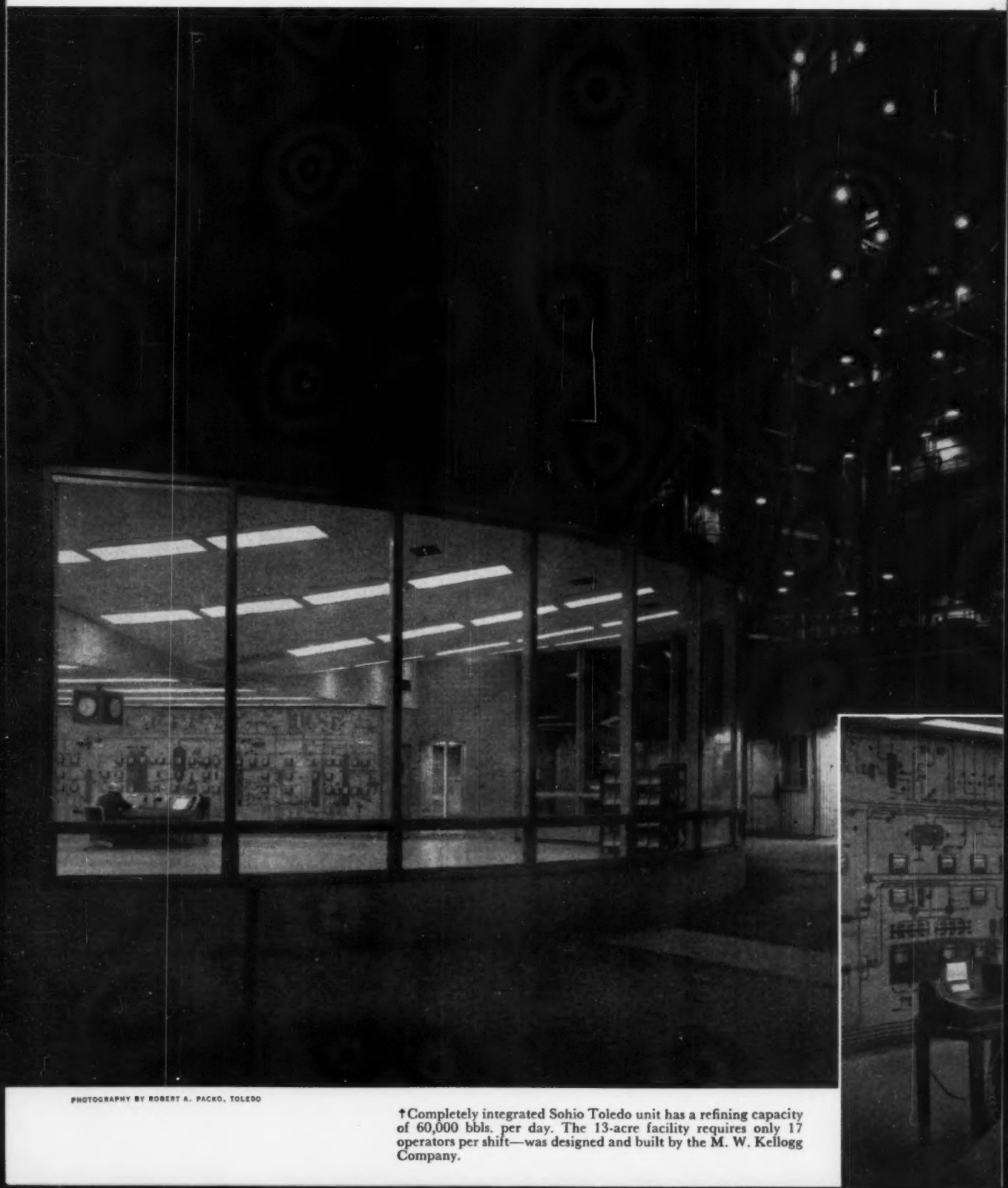
For complete information, call your Stockham Distributor or write

WEDGEPLUG VALVE COMPANY
DIVISION OF
STOCKHAM
VALVES *and* FITTINGS

General Offices and Plant
4003 NORTH 10th AVENUE, BIRMINGHAM 2, ALABAMA

SOLD ONLY THROUGH DISTRIBUTORS

It's Foxboro Consotrols



PHOTOGRAPHY BY ROBERT A. PACKO, TOLEDO

†Completely integrated Sohio Toledo unit has a refining capacity of 60,000 bbls. per day. The 13-acre facility requires only 17 operators per shift—was designed and built by the M. W. Kellogg Company.

. for SOHIO

Reliable instrument performance a "must" at fully-integrated Toledo Refinery

Crude in at one end — finished product out the other—one continuous operation. That's the process flow at Standard Oil of Ohio's new 60,000 bbl. Toledo Refinery.

Since intermediate tankage has been eliminated, reliance on instruments approaches 100%. If one unit stops, the whole plant must stop — integration is that complete.

You'll find Foxboro Consotrol* instrumentation on every phase of this bold, cost-cutting refinery design. Accurate, dependable, low-maintenance Consotrols — pneumatic and electronic. The same "reliables" serving refineries the world-over.

If you're not already familiar with the Consotrol story ask your nearby Foxboro field engineer for full details. Or write Foxboro for Bulletin 13-18. The Foxboro Company, 749 Neponset Avenue, Foxboro, Massachusetts. *Reg. U.S. Pat. Off.*

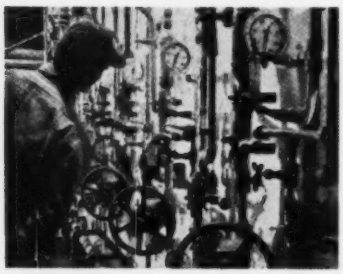
FOXBORO
REG. U.S. PAT. OFF.

↓Nerve center at Toledo is this 96-ft. Foxboro-instrumented control panel. Six "satellite" panels handle local control. Since unit must work as one continuous operation—or not at all—reliable instrument performance is essential.

What the RMC system of recalibration means to you

Sometimes it is necessary to recalibrate industrial thermometers due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

Various recalibration systems are employed in the different makes of ordinary bimetal thermometers. Most all of them will achieve the desired recalibration, but a number of undesirable things may also result. In some, all semblance of air-tight seal is automatically destroyed in removal of the dial glass. In others, the critical pointer shaft may become bent or twisted. And still others use a mechanism incapable of holding the new setting for any length of time. *None of these things can possibly happen with RMC's patented recalibration device.*



SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

A simple dial-reset screw, located on the back side of RMC thermometers, permits recalibration without opening the instrument in any way—thus leaving its air-tight hermetic seal intact. Its positive meshed-gear mechanism rotates the dial itself in a way that cannot under any circumstances cause damage to the pointer shaft. And the new setting will hold indefinitely.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 38 Rockwood St., Rochester 10, N. Y.

The simplicity of recalibrating an RMC bimetal dial thermometer is illustrated above. *Patented RMC system leaves hermetic seal undisturbed, prevents damaging of critical pointer shaft.*

RMC external recalibration device saves time and your thermometer

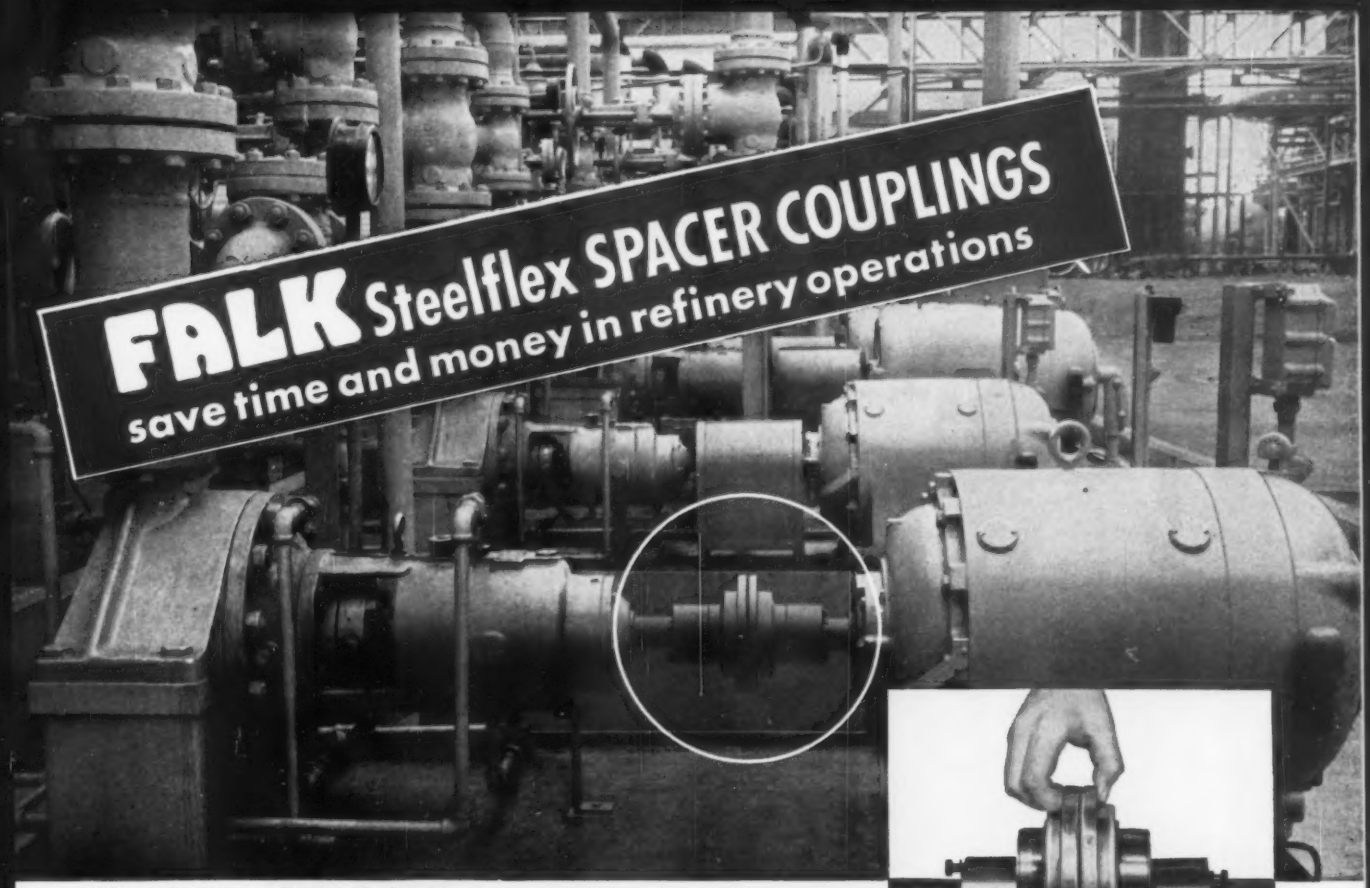
With the patented RMC dial reset screw you can recalibrate your thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed, and there is no chance for damage to the critical pointer shaft.

RMC

ROCHESTER MANUFACTURING CO., INC.
38 ROCKWOOD STREET • ROCHESTER 10, N. Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES



FALK and STEELFLEX are Registered Trademarks

Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit.* This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

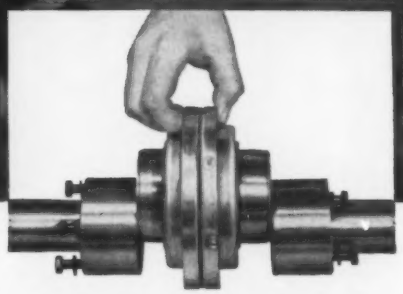
Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS
Representatives and Distributors in many principal cities.

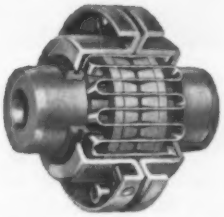


EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



The heart of the FALK Spacer ...the basic Type F Steelflex
Write for Service Manual 4838

FALK
...a good name in industry

Make shorter work of TURNAROUNDS

Every OAKITE ECP utilizes chemical cleaning for towers

Where carbon and iron oxides and sulphides must be removed: circulate Oakite 85. Combining acid and solvent cleaning properties Oakite 85 penetrates heavy scales and corrosion-type soils, tears them from equipment walls, then rinses freely and completely. It's safer than raw acids, because it's inhibited against attack on ferrous metals . . . easy on synthetic rubber. One user says:

When this 40-ft., 12-tray tower was off-stream previously, "hand" cleaning required 5 days and $3,000. Using Oakite 85 by circulation method, we did a complete job of removing fouling soils in just 32 hours . . . for only $750.

For heavy oil, grease-laden soils and light rusts: circulate Oakite 77. Heavy-duty alkaline cleaning properties make Oakite 77 superior for penetrating, dissolving and dispersing heavy-oil and carbonaceous soils. It picks up light rust, too . . . leaves towers and tubes in top operating condition.

In cases where extra boosting power is called for to remove abnormally stubborn soils—add Oakite Acalaid to your cleaning solution. This brand new additive permits deeper penetration of soils . . . intensifies the purging action of your acid or alkaline cleaning agent . . . gives you a speedy, economical answer to your toughest tower-cleaning problem.

with an Oakite ECP

engineered cleaning program

A 90-foot tower cleaned in 15 hours . . . crude tower and heat exchanger purged to 99% cleanliness in 21 hours . . . partly plugged bundles saved from the scrap pile in just a few hours . . . 3½ *days* cut from previous record for cleaning an absorber . . . 5 days slashed from catalytic reformer turnaround time. These are *some* of the results of Oakite technical service.

In each case, the procedure was initiated through the tower and tube bundle recommendations of an Oakite ECP. Did they save time, save cost, save trouble? You bet!

WHAT IS OAKITE ECP?

It's an Engineered Cleaning Program that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by materials known to make short work of refinery soils, by proved *methods.*

Ask the Oakite Engineer to recommend the best procedure for your next turnaround and follow up with an ECP for your refinery. Or, send for Bulletin F-10102 on tower and heat exchanger cleaning. Write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

OAKITE

over 50 years' leadership in industrial cleaning

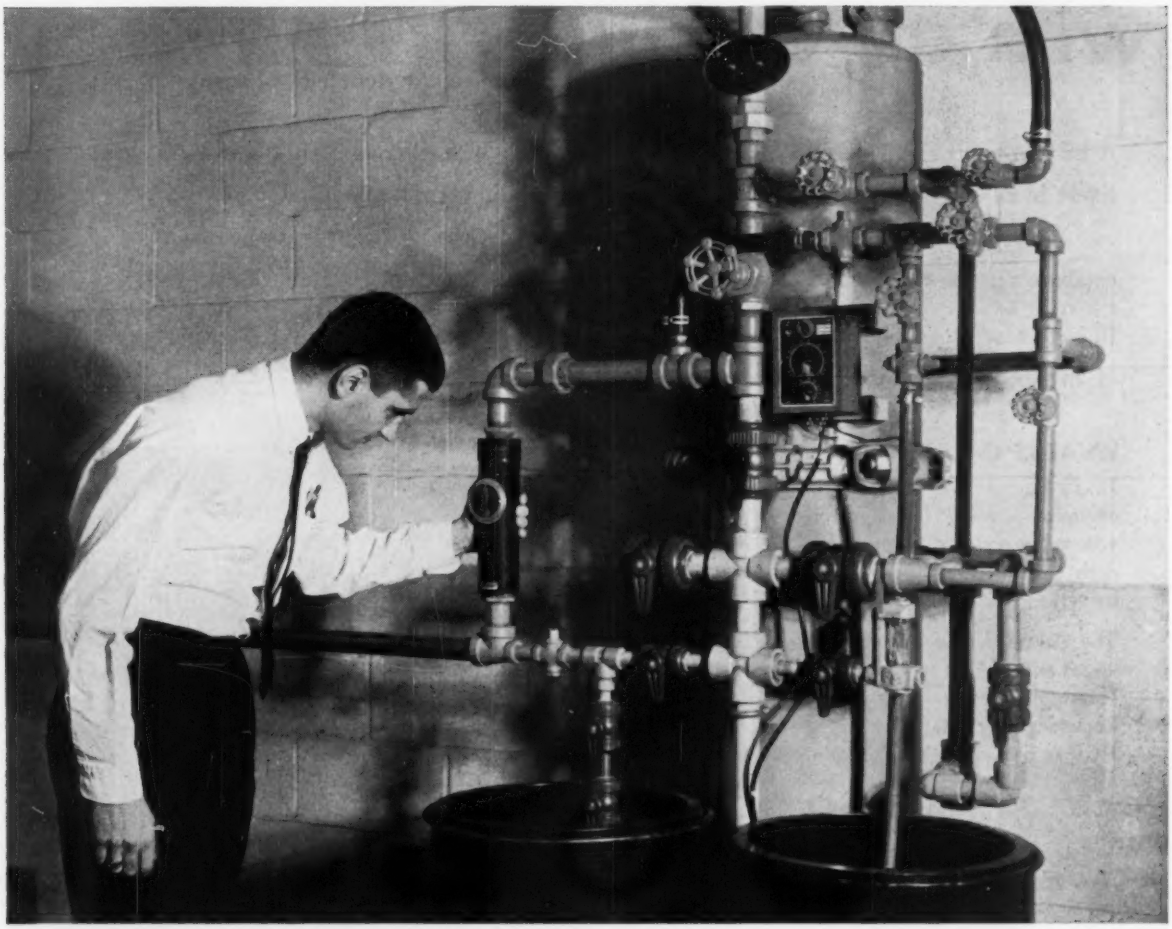
Est. 1909 SCIENCE

Oakite ECP

your economy key

For more data on advertised products, use Readers' Service Cards, last page.

FLUIDICS* AT WORK



MODEL MBD-15A, one of a complete line of "packaged" Permutit ion exchange units, demineralizes 5 to 10 gpm of water to an average conductivity of 0.15 micromhos.

Now! Two-week shipment available on standard Permutit demineralizers

In 14 days, often less, you can now get shipment of standard Permutit ion exchange equipment to demineralize water for your process or production plant. Here are several models on which you can now get this fast, time- and money-saving service.

For 5 to 20 gpm . . .
"packaged" mixed-bed demineralizers

These compact skid-mounted, pre-tested units will demineralize 5 to 20 gpm of water to an average conductivity of 0.15 micromhos (approximately 6,000,000 ohms specific resistance per cm or 0.05 ppm total electrolyte content). CO_2 will be reduced to 0.1 ppm and SiO_2 to about 0.1 ppm. Shipped fully piped, filled with resin, ready to run when you make inlet, outlet and drain connections. Available from stock in four sizes, 12″–15″–20″–24″ diameter.

For 10, 20, 30 gpm . . .
three high-volume units

16″, 24″ and 30″-diameter single-bed units will demineralize 10, 20 and 30 gpm respectively. Like the skid-mounted mixed-bed demineralizers, construction of these units is of the same heavy-weight materials used for Permutit's custom-designed equipment. This includes rugged PVC plastic interior piping and plastic strainers. Steel shells are lined with ☆″-thick PVC plastisol, spark-tested at 10,000 volts. Single-bed units are shipped knocked down, ready for simple and fast field erection and installation.

For lab, pilot plant . . .
MBD-6A mixed-bed demineralizer

This 6″-diameter unit contains a mixture of Permutit Q cation exchange resin and Permutit S anion exchange resin.

It will demineralize 1 to 2 gpm of water to a low total solids, low CO_2 and low silica content.

How they work, what they include

We shall be happy to send you full details on the operation of these units, the results you can expect, facts about their construction and installation. Ask for Bulletin No. 4721 or a consultation.

For more data on advertised products, use Readers' Service Cards, last page.

Glasteel pipe that you can field-cut

Here's a new, rugged, corrosion-resistant Glasteel pipe that you can cut to any length you want with a standard, dry abrasive cutoff wheel.

It's Pfaudler F-C (for "field-cut") pipe.* Once you cut the length you want, you thread, fire-polish and then finish with a belt-sander to provide a flat gasket seat.

Outside, the pipe is steel for strength; inside you have a ⅛-inch-thick glass lining that stands up to all acids (except HF) to 350° F. and to most mild alkalies at moderate temperatures. You can also use this pipe with abrasive fluids, sticky materials, and those you want to protect from contamination.

Pipe is rated at 150 psi and comes in 1½, 2 and 3-inch diameters, in lengths through 10 feet. Stock delivery.

Bulletin No. 989 provides complete specifications.

*Patent applied for

Ion Exchange . . . practical, profitable unit process

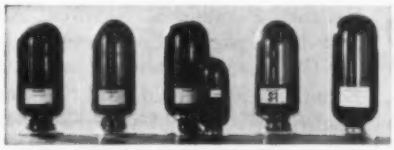
Ion exchange, the Permutit way, is a standard, unit operation for: purification, concentration, separation and addition. A versatile process, it involves many types of dilute solutions.

As the only manufacturers of both resins and equipment, Permutit is best able to control the ion exchange operation from beginning to end.

Rely on any or all of our services:

1. Technical assistance. Your problem and process will be thoroughly and expertly evaluated in terms of what ion exchange can do.

2. Wide choice of resins. From among Permutit's more than 30 ion exchangers, those best suited for your needs will be specified. In this wide selection you'll find many unique and specialized cation and anion exchangers, mixtures and miscellaneous adsorbents.



OVER 30 ION EXCHANGE RESINS are available from Permutit, along with the know-how and equipment that can help you get the most from this recognized unit operation. Samples on request.

3. Dollar-saving equipment. Frequently the equipment you need is already available as a "package" or can be quickly assembled from standard, stocked components. Naturally, custom units are also part of our service, and automatic equipment was pioneered by Permutit.

If you're interested in ion exchange, either (a) send for a 12-page booklet, "Permutit Ion Exchangers," or (b) send us an outline of your problem.

NEW FROM PERMUTIT!

Complete line— all-purpose Model BD Economy Softeners

Here's an answer to your need for more and more soft water at lower cost.

Taking advantage of new design advancements and standardized mass produced components, new Permutit Model BD Softeners now make Permutit quality available in a complete line, ready for prompt delivery from stock at economy prices.

BD Softeners contain only high-capacity Permutit Q Resin. Absence of subfill eliminates possibility of upsetting bed, makes installation simpler, less expensive. Exclusive double-dish underdrain is shipped completely assembled, further simplifies installation. Standard valve is the famous Permutit Multiport® type.

Available in flow rates of 40, 56, 77 and 100 gpm – with softening capacities of 510, 750, 1020, and 1380 kgr, respectively. Bulletin 4696 gives BD specifications and other details.

Handy FLUIDICS Buyer's Guide

gives you a complete look at the many products and services you can get through the Fluidics program. It shows you how to get answers to problems in such fields as water and waste treatment, corrosioneering, reaction, metering, fluid control, etc.

For your free copy, write to our Permutit Division, Dept. PR-90, 50 West 44th St., New York 36, N. Y.

*FLUIDICS is a new Pfaudler Permutit program that provides a modern, imaginative approach for handling and processing liquids and gases more profitably.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS...the science of fluid processes

For more data on advertised products, use Readers' Service Cards, last page.

SERV-RITE
DRILLED WELLS

thermometer sockets
thermometer test wells
thermocouple wells

FOR PLUS SERVICE

SERV-RITE drilled protecting wells are made in types, lengths, and of alloys to meet any temperature and pressure condition in vessels and flow lines.

Every well is carefully made to assure a plus service. Selected bar stock is machined to within accurate limits. Bore concentricity is held within 5% of wall thickness, depending on well length. They are tested to withstand pressures up to 3000 psi., depending on the wall thickness. Exterior surface has a mirror-like finish for minimum resistance to flow in lines.

Complete assemblies can also be furnished with suitable thermocouple, head, flange, fittings, etc.

Give SERV-RITE a trial on your next drilled well requirements. There is none better.

Booth No. 520—I.S.A. Show

Write for Bulletin No. 2000

for specifications, size, and ordering information on SERV-RITE drilled wells.

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

615 West 30th Street, Chicago 16, Illinois
2019 Hamilton Ave., Cleveland 14, Ohio

The Mail Box...

Simplicity, Here's How

To The Editor:

The temperature conversion method as submitted by Art Whistler, The Fluor Corp., Ltd., Los Angeles and published in the May, 1960, issue of PETROLEUM REFINER, page 271 is quite clever and simple, and as stated is faster than looking up tables.

However, for the sake of speed and simplicity, while at the same time retaining accuracy, I believe the standard method of conversion would take precedent:

Rule: To change °C to °F multiply °C by 1.8 and subtract 32 from the product.

To change °F to °C subtract 32 from °F and divide the remainder by 1.8.

Example: To convert 100° C into °F, multiply 100 by 1.8 = 180; then add 32 to 180 = 212° F.

To convert 212° F into °C, subtract 32 from 212 = 180; then divide 180 by 1.8 = 100° C.

J. A. Kuntze
The Chemstrand Corp.
Pensacola, Fla.

Erratum

To The Editor:

In proof reading the galley of Part 4 ("Figure Distillation this New Way," by W. N. Lyster, S. L. Sullivan, Jr., J. A. McDonough and C. D. Holland, PETROLEUM REFINER, August 1960, page 121) we overlooked the fact that the subscript on L in Equation (91) should read "j-1" instead of "j". I would appreciate your calling this to the attention of your readers.

C. D. Holland
Professor of
Chemical Engineering
A. & M. College of Texas,
College Station.

Ohio This Time

The byline credit to the article "Tube Rolling Techniques For Your Plant," which appeared in PETROLEUM REFINER's August issue incorrectly gave Howard Bach's address as Elliott Company, Springfield, Illinois. It should have been Springfield, Ohio.

"Horse Sense"

To The Editor:

There is a lot of good horse sense in the article by John McKetta, "How Professional is your Management." (February 1960 PR, Page 190). The test is good and the questions valid. I believe you will get two sets of answers in some cases, depending on how an individual thinks of his situation. It would be good if you would persuade a few management people to use the test for self analysis. I believe you would get some letters of thanks for opening their eyes. I like your approach and efforts to promote truly a professional working team.

E. E. Ludwig
Lake Jackson, Texas

"B," Not "D"

To The Editor:

Permit me first to thank you for your excellent job of editing "How to Determine Low-Temperature Storage Costs," (July 1960 PETROLEUM REFINER, p. 115) but, second to point out that you awarded me a Doctorate from the University of Chicago, which I am sorry to say I never received.

I did receive the degree of Bachelor of Philosophy from Chicago and suspect that somewhere in the transmission of data the "B" became a "D" since the degree Ph.B. is rather an unusual one.

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For a partial listing of Kellogg Processing experience, see :

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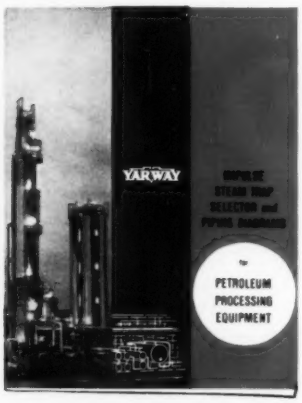

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OUR INDUSTRIAL ADVISORS for the 1960 Process Handbook are shown above, starting at the left: A. R. Dudley, Jr., Tennessee Oil Refining Co.; F. Formway, Sinclair Refining Co.; M. Mandel, The Atlantic Refining Co.; J. H. Eppard, DX Sunray Oil Co.; and H. D. Radford, The American Oil Co. They helped establish the limits and type of material included in this edition of the Handbook.*

1960 PROCESS HANDBOOK

The most complete and up-to-date assembly of refining processes of importance to the modern refiner is contained in this new edition of the Process Handbook. This edition includes the eight new processes announced to the industry since the last previous publication of the Handbook two years ago. Other processes are added for the first time in order to give a comprehensive coverage of the processes available today.

To assure authoritative information, the process descriptions are presented by companies active in the field. You should remember, however, that the contributor of the unlicensed processes may not be the only one qualified to design and construct the process for your refinery.

All of the refining processes are here—classified and summarized into broad processing categories for easy reference. The descriptions reflect the greater emphasis given economic data on installation and operation costs. And if you need more detailed information, literature references accompany most of them to tell you where to look.

Now when you hear an unfamiliar process name, you need only flip to the index of this handbook. The 1960 edition will make a valuable addition to your reference files.

Harold L. Hoffman

PROCESS AND CONSTRUCTION EDITOR

* The attendance by executives, engineers, superintendents, and other employes of oil and petrochemical companies at these conferences does not constitute an endorsement of Petroleum Refiner over any other one publication. The fact that men of outstanding ability are allowed to attend these planning conferences shows the interest which the oil and petrochemical industry has in sound editorial content planned for the benefit of the industry and those who work in it.

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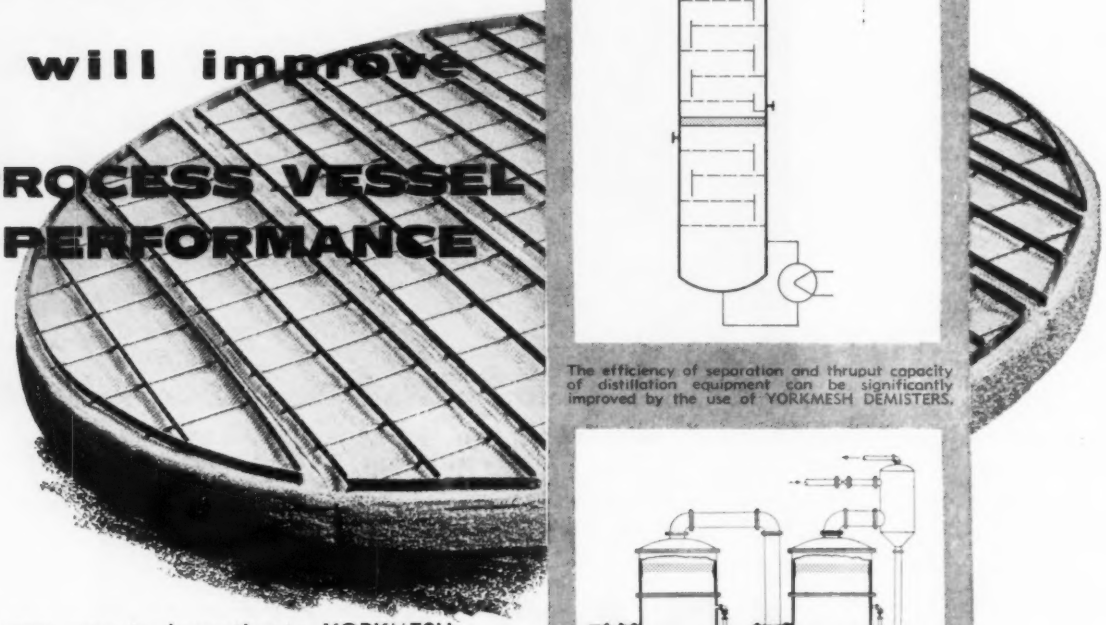

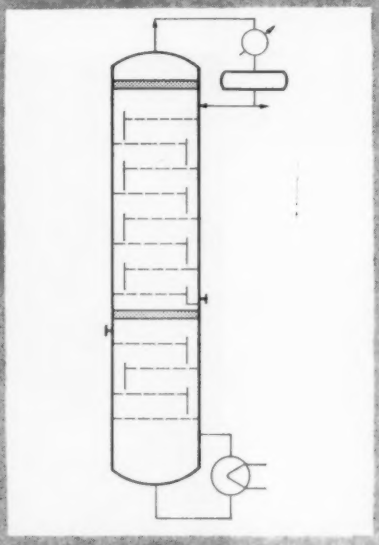

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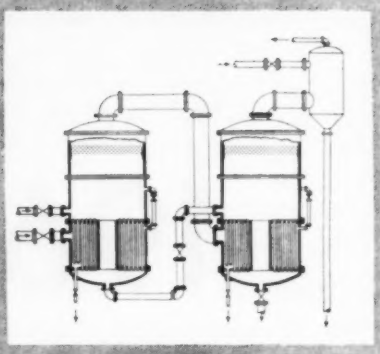

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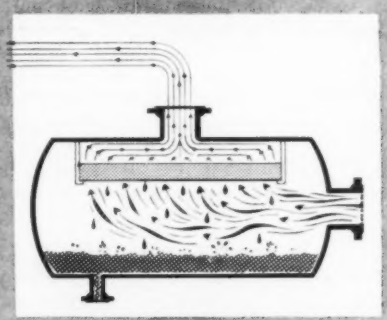

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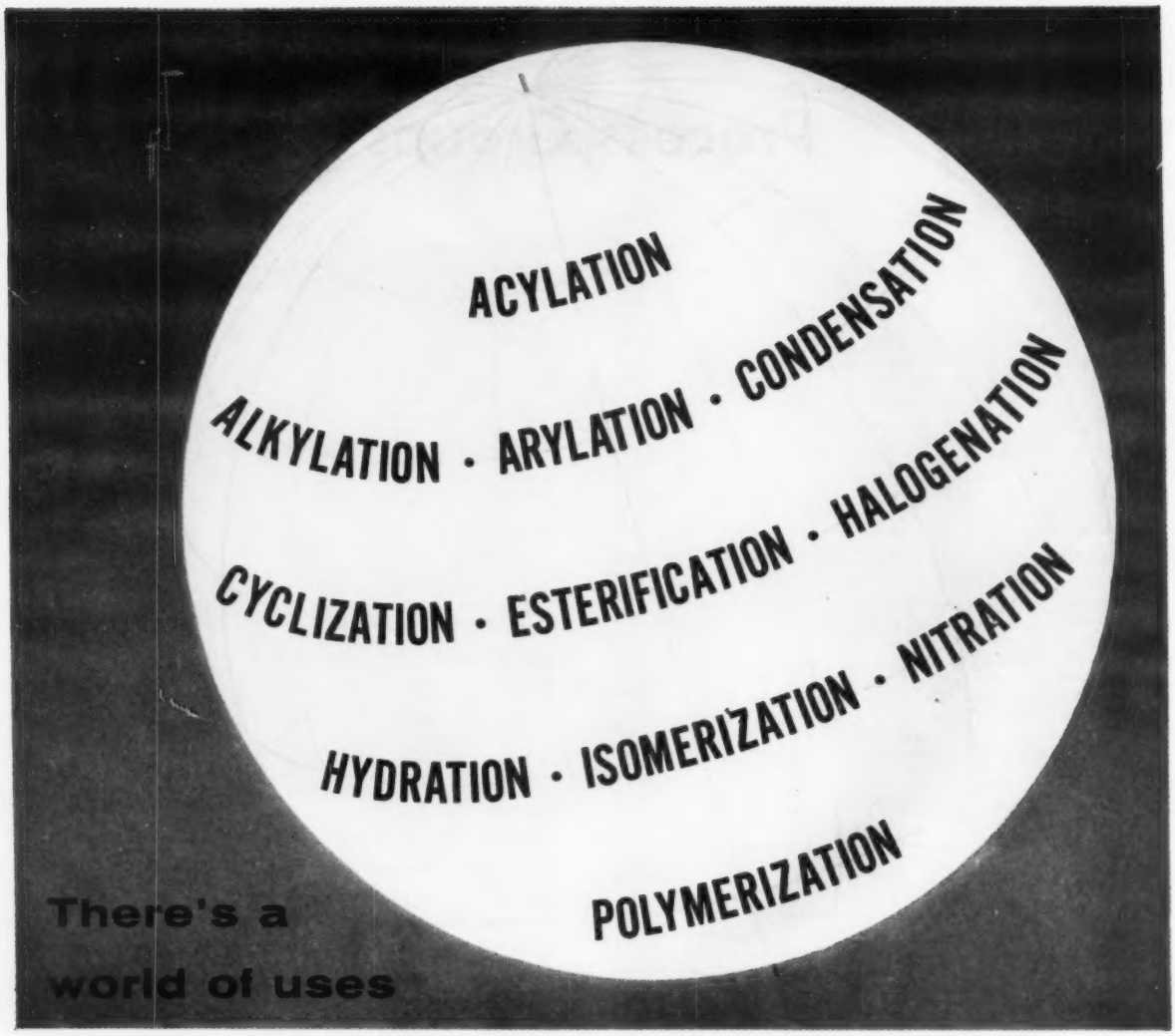

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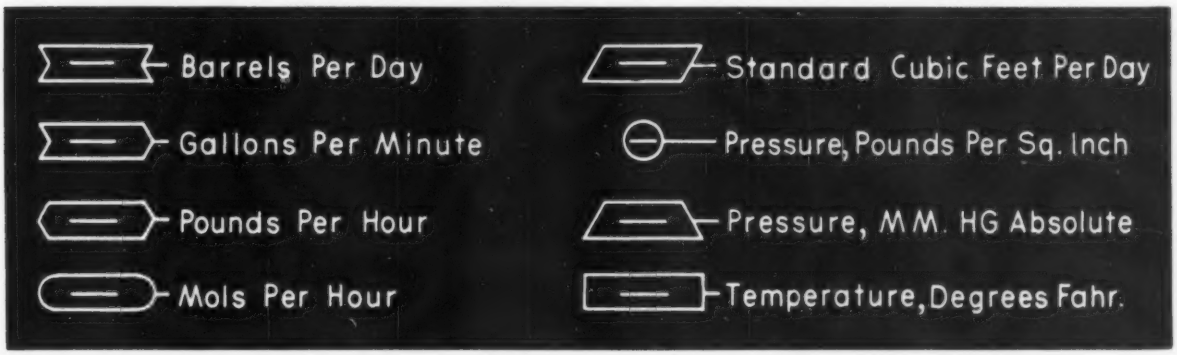

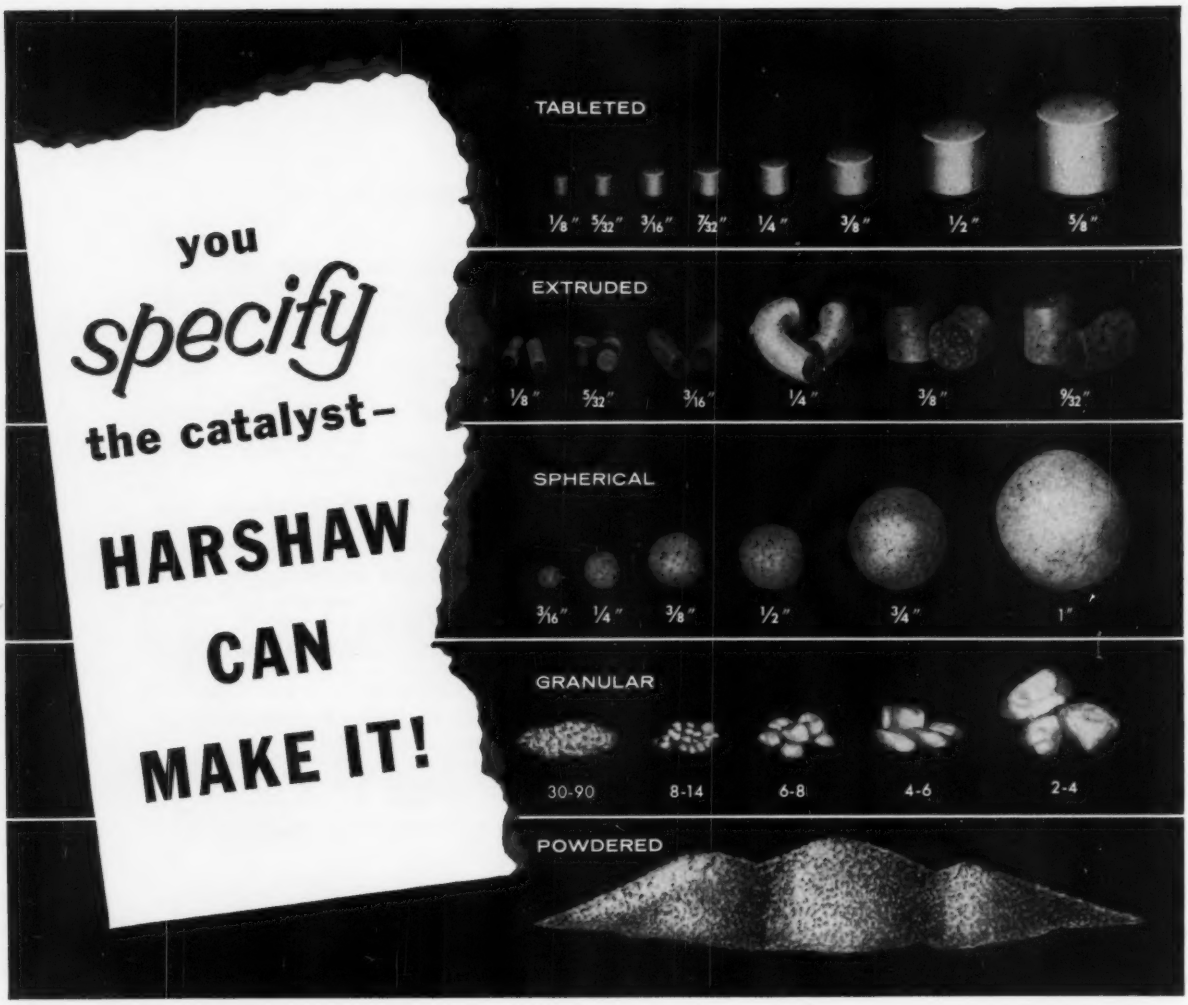

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Cracking

CRACKING in U.S. refineries has become almost synonymous with catalytic cracking. No new thermal cracking units have been built so that thermal units now represent only about 30 percent of the total domestic cracking capacity in operation.

New developments in catalytic cracking have not turned up any significantly different processing techniques. The latest efforts to improve cracking have been concentrated on new catalyst formulations.

Cracking is used to produce more gasoline from a barrel of crude. The heavy portions of crude having boiling points that are too high to be included in gasoline are decomposed into lighter more suitable materials by the cracking process. At the same time some of the materials combine with one another to give even heavier materials than those in the original charge stock. The more stable materials leave the system as cracked gas and gasoline, while the reactive ones polymerize, forming cracked fuel oil and coke.

Catalytic cracking, in contrast to thermal cracking, gives rise to more selective cracking and less light-ends products. In addition, the catalyst is more effective in causing cyclization and some isomerization to produce aromatics, naphthenes, and isoparaffins. Higher investment and operating costs of the catalytic process are balanced by increased product quality.

The latest innovation to catalytic cracking is the use of two reaction stages. The first stage takes advantage of short-contact-time cracking to produce gasoline from the less refractory material. Then the gasoline is removed before the gas oils are subjected to the more destructive cracking of the second stage.

Feedstocks for catalytic cracking can range from naphtha cuts to reduced crude, but the most commonly used feed is a gas oil with an initial boiling point slightly higher than the end point of the gasoline to be produced.

With heavy stocks, feed preparation techniques usually must be employed to remove salts and asphalts before charging to catalytic cracking operations. Some of the feed preparation methods are as follows: viscosity breaking, coking, vacuum distillation, solvent extraction or hydrodesulfurization.

Visbreaking is a variation in thermal cracking in which the charge stock is residual fuel oil or reduced crude. The charge is cracked under such mild conditions that coke formation is minimized. Thus the viscosity of the fuel oil is reduced and a clean gas oil is produced which is suitable for catalytic cracking. However, coking now is the more popular process for handling such stocks.

Coking is in itself a form of cracking. It extends the time of cracking so that coke is formed instead of minimized as in the conventional thermal and catalytic cracking processes. Since the charge stock is residual fuel oil or reduced crude, the process furnishes a way to upgrade residual fuels into gasolines and gas oils. Gas and solid coke are byproducts of the process.

Fluid coking uses coke particles as seeds in the formation of coke. These coke particles are removed continuously from a fluidized bed. Major advantages claimed for this fluid process are its continuous nature, made possible by the coke circulation system which requires minimum physical handling, and the fact that the process normally requires no external furnace.

A comprehensive article on catalytic cracking processes is given by Marshall Sitting in "Catalytic Cracking Techniques in Review." PETROLEUM REFINER 31, No. 9, pp 263-316 (1952).

Hydrocracking

CRACKING PROCESSES which are carried out in a hydrogen atmosphere are getting continued interest. Of the four hydrocracking processes described in this edition of the Handbook, three were announced for the first time within the last year.

Hydrocracking offers a way to reduce heavy residual stocks to gasoline and valuable middle distillate products. By adjusting operating conditions this process gives flexibility in shifting product distribution between fuel oils and gasoline.

Suitable catalysts are available now which permit the hydrocracking reactions to be carried out at less severe conditions than before. Temperature ranges from 400 to 900° F. Pressure is less than 2,000 psig. Hydrogen consumption is less than 2,000 scf/bbl of charge. Actual operating conditions depend upon the charge stock and the degree of hydrogenation required.

Deep hydrogenation is not the only reaction which is of interest to the refiner. The hydrocracking technique also can be used to desulfurize light distillate, improve diesel index or cetane number of cracked middle distillates or increase the production of isomerized light-ends materials.

Airlift TCC—SOCONY MOBIL OIL COMPANY, INC.

Application: The Thermofor Catalytic Cracking process is used primarily to (1) produce high quality gasoline, (2) increase the yield of distillate fuel fractions, and (3) reduce the yield of residual fuels. Byproducts of TCC operations are large yields of valuable feed stocks for alkylation and catalytic polymerization units.

Charge: In commercial practice a wide variety of feed stocks are charged to these units. Full range gas oils either virgin or previously processed are concurrently employed and in some cases whole crude may be charged. The feed is sometimes supplemented with straight-run naphtha in order to realize an octane number improvement and a degree of desulfurization.

Products: The flexibility of the process and the available range of operating conditions permit variations of product distribution. Thus, gasoline, octane rating, or burning fuels may be maximized to fit the economics of the particular refinery. The high ratio of isobutane to butenes is advantageous where secondary processing includes alkylation.

Description: The first commercial TCC unit was placed onstream in 1943. In 1950 the first Airlift TCC was started up, in which the original design was modified by superimposing the reactor over the kiln and replacing the bucket elevators with a catalyst airlift. These changes resulted in reduced investment costs, simplified operation and improved flexibility. Continuing progress in design improvements have given existing units increases of up to 100 percent in reactor and kiln capacity at little modification expense. Referring to the accompanying flow diagram, the charge is first heat exchanged against fractionator streams combined with recycle (if any), heated and charged to the reactor as a mixture of vapor and liquid. Alternate feed preparation systems may employ a tar separator and a vacuum jug, or some prior processing step such as visbreaking, coking or propane deasphalting.

In the catalytic section regenerated catalyst slowly flows by gravity down the seal leg from the surge hopper to the reactor. Sealing steam or flue gas flows countercurrently upwards, thereby permitting the pressure to increase from atmospheric in the surge hopper to as much as 20 psig in the reactor. In the reactor, catalyst flows slowly through a reaction bed of uniform depth, past vapor collecting grids, through a purge zone, and out of the reactor. The purged spent catalyst from the bottom of the reactor gravitates into the top of the kiln and then through the kiln where it first contacts flue gas of low oxygen content in the upper (countercurrent flow) section. As the catalyst passes downward in the kiln, its temperature is raised by the combustion of the coke, and then reduced by the incoming air. In the lower section of the kiln the air and catalyst flow concurrently downward, the flue gas is disengaged and the catalyst passes to the coolers. These coolers remove excess heat of coke combustion by generating steam and are controlled to cool the catalyst to the desired temperature for return to the reactor section. The regenerated catalyst flows from the coolers into the lift pot where it is picked up by low-pressure air (introduced at 2 to 3 psig) and lifted to the surge hopper at the top of the unit. The catalyst is separated from the lift air in the surge hopper and flows slowly down the seal leg to complete the cycle.

The effluent vapors from the reactor flow to simple fractionating and gas recovery systems to separate the cuts desired for blending into final refinery products. The TCC reactor effluent contains essentially no inert gases that would increase recovery problems.

Synthetic bead catalyst are generally preferred for use in these units. The catalyst now in production has all the yield and stability advantages of the former standard chrome bead catalyst plus greatly increased structural strength and carbon burning capacity. Commercial data indicate catalyst usage now will average less than 0.14 pounds per barrel of feed.

Operating Conditions: A wide range of flexibility allows conditions to be tailored to any feedstock. Typical values are: Reactor space velocity 1-2.5 (vol./hr./vol.), catalyst-to-oil ratio 2-5 (volume), average reactor temperature 840°-950° F., and recycle to fresh feed ratio 0-2 (volume).

Yields:

Crude Source	Mid-Continent	Kansas	Mississippi
Gas Oil Type	Virgin	Virgin	71% Virgin +29% Fluid Coker
Yields			
Gasoline, Vol. %	56.5	56.3	54.8
Lt. Cycle, Vol. %	26.0	15.0	10.5
Hvy. Cycle, Vol. %	4.1	17.0	6.7
Butanes, Vol. %	7.5	10.8	15.7
Propanes, Vol. %	10.2	8.8	17.7
Dry Gas, Wt. %	3.5	2.3	4.4
Coke, Wt. %	5.0	5.2	10.6
Properties			
Charge Gravity, °API	30.0	26.5	21.8
ASTM Distil. °F			
10%	550	657	460
50%	720	835	600
90%	940	1024	900
Gasoline, RVP	8.0	10.5	7.5
ASTM Distil. °F			
10%	135	137	133
50%	230	230	225
90%	385	395	347
F-1 O.N. + 3 cc	98	97.2	98 (Estd.)

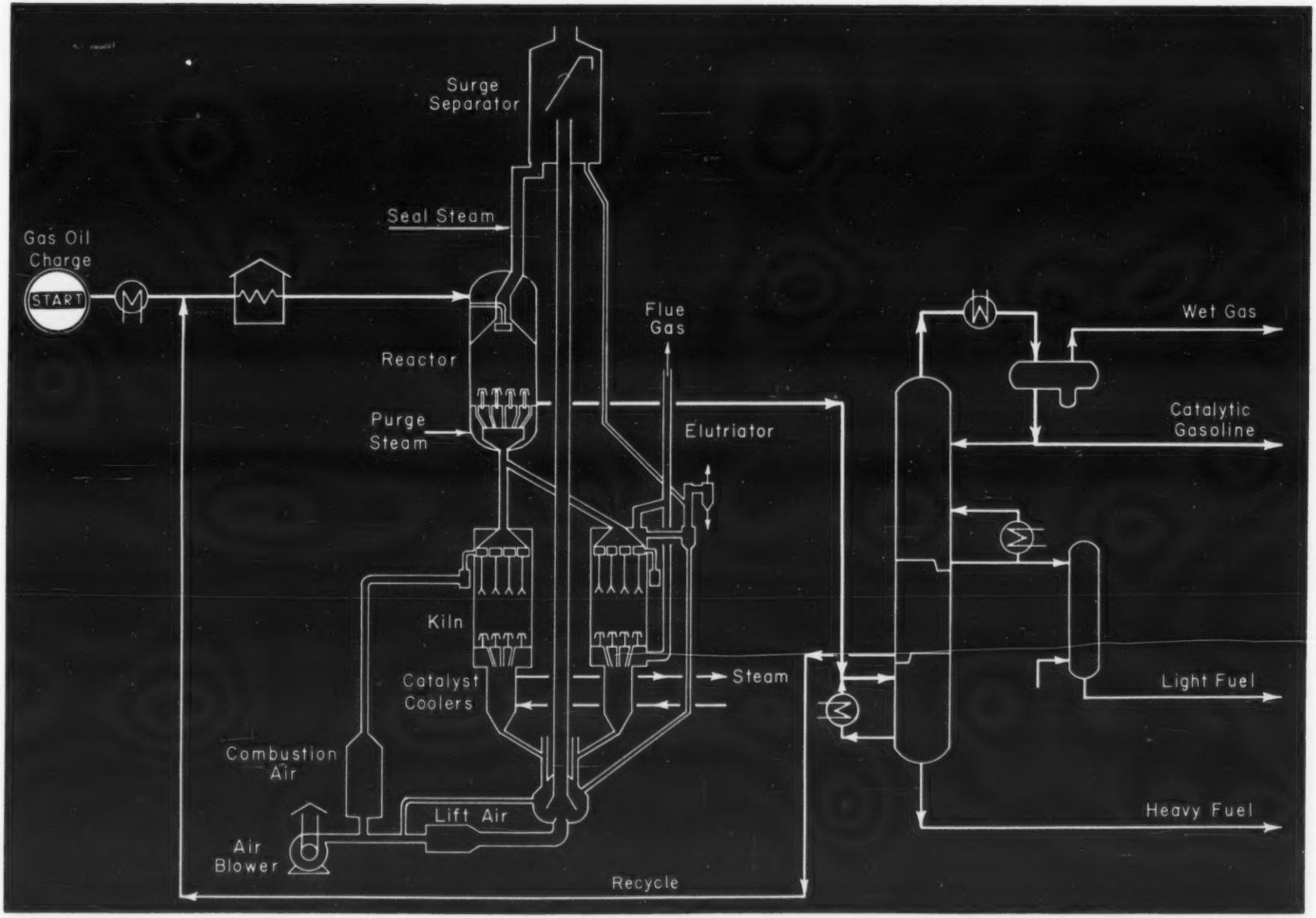
Economics: Investments costs are $120-$280 per barrel from 4,000-50,000 barrels per stream day (excluding gas concentration facilities). Typical utility and chemical consumptions are shown below:

Item	Per Bbl. Feed
Steam (net production)	128 lbs.
Power	2.2 kwh
Water	390 Gallons
Fuel	0.14 MM Btu
Catalyst	0.10 lbs.

Annual maintenance material and supplies are approximately 1.5 percent of investment, and maintenance labor not more than 1.8 yearly man-hours per barrels per day feed.

Commercial Installations: As of June, 1960, 49 Airlift TCC units are in operation and 4 units are under construction. These units range from 1600 barrels per day to over 30,000 per day fresh feed capacity, and from 1600 to over 30,000 pounds per hour carbon burning capacity. The total throughput capacity of operating Airlift TCC units is well over 800,000 barrels per day.

Reference: PETROLEUM REFINER 31, No. 8, 71 (1952).


Surge Separator
Seal Steam
Gas Oil Charge
START
Reactor
Flue Gas
Wet Gas
Purge Steam
Elutriator
Catalytic Gasoline
Kiln
Catalyst Coolers
Steam
Light Fuel
Combustion Air
Lift Air
Heavy Fuel
Air Blower
Recycle

Fluid Catalytic Cracking — UNIVERSAL OIL PRODUCTS COMPANY

Application: To convert distillate oils into high octane gasoline and to reduce the over-all refinery fuel oil production. Current designs are noted for simplicity, ease of operation and low operating and investment costs.

Charge: A wide variety of stocks from all types of crudes. Typical feeds may be either virgin or cracked and include naphtha, kerosine, light gas oils, wax distillates, atmospheric and vacuum gas oils and distillates from vis-breaking and coking. Feeds may be high in nitrogen and sulfur compounds and, in some cases, may include some desalted crude.

Description: A typical flow diagram for a 5,000 bpsd unit is shown, featuring reactor and regenerator in a single vessel. The gas oil feed, cold or hot, is charged together with recycle into the hot regenerated catalyst stream, is vaporized, and passes to the reactor. Vapors from the reactor, carrying some catalyst, pass upward through the reactor cyclone separator, which removes most of the entrained catalyst, and into the fractionating column.

The spent, or used, catalyst passes downward from the reactor through the steam stripper and enters the regenerator where the carbon deposit is burned off. Oxygen for combustion is supplied by air from the air blower. The flue gases carrying some catalyst pass upward through the regenerator cyclone separators where entrained catalyst is removed, and pressure is released in a pressure reducing chamber which serves as a noise eliminator. The regenerated catalyst again enters the incoming gas oil charge stream to repeat the cycle.

An external feed preheater is optional. The initial heat to bring the unit onstream is supplied by a direct-fired air preheater and torch oil in the regenerator.

The fractionating column is of standard UOP design, with gasoline taken overhead and one or more selected fractions withdrawn as sidecuts. The net column bottoms are sent to storage via the slurry settler. Steam may be generated by recovery of heat in the fractionator column bottoms. Catalyst-containing oil from the bottom of the slurry settler is returned to the reactor with the fresh feed.

The unstabilized gasoline and gas pass to a gas fractionation section for debutanization and recovery of C_3-C_4 polymerization unit feed.

The UOP regenerator design utilizes pressure to increase the coke-burning rate, which permits a smaller sized regenerator and correspondingly less catalyst inventory. The catalyst inventory of a 5,000 bpsd unit with a coke burning capacity of 4,233 pounds per hour at 53 percent conversion (gas oil disappearance) is approximately 37 long tons. Catalyst loss at 53 percent conversion will not exceed 0.25 pound per barrel of fresh feed; at 70 percent conversion, loss will not exceed 0.40 pound. This is approximately equivalent to desirable make-up rates in maintaining constant catalyst activity. Actual catalyst consumption in many commercial units has been reported in the range of 0.1 to 0.2 pounds per barrel of fresh feed.

It has been found advantageous to subject high sulfur feeds to Unifining before charging to catalytic cracking, especially if a part of the feed is derived from certain types of coking operations. Not only is the sulfur greatly reduced, but heavy metals contents are substantially lower. There also is considerable evidence that the cracked product distribution is benefited. Alternatively to Unifining feed, certain cracking units can benefit from Unifining the gas oil recycle. The most apparent benefits in operation are a reduction in coke make and a small increase in the yield of desirable products.

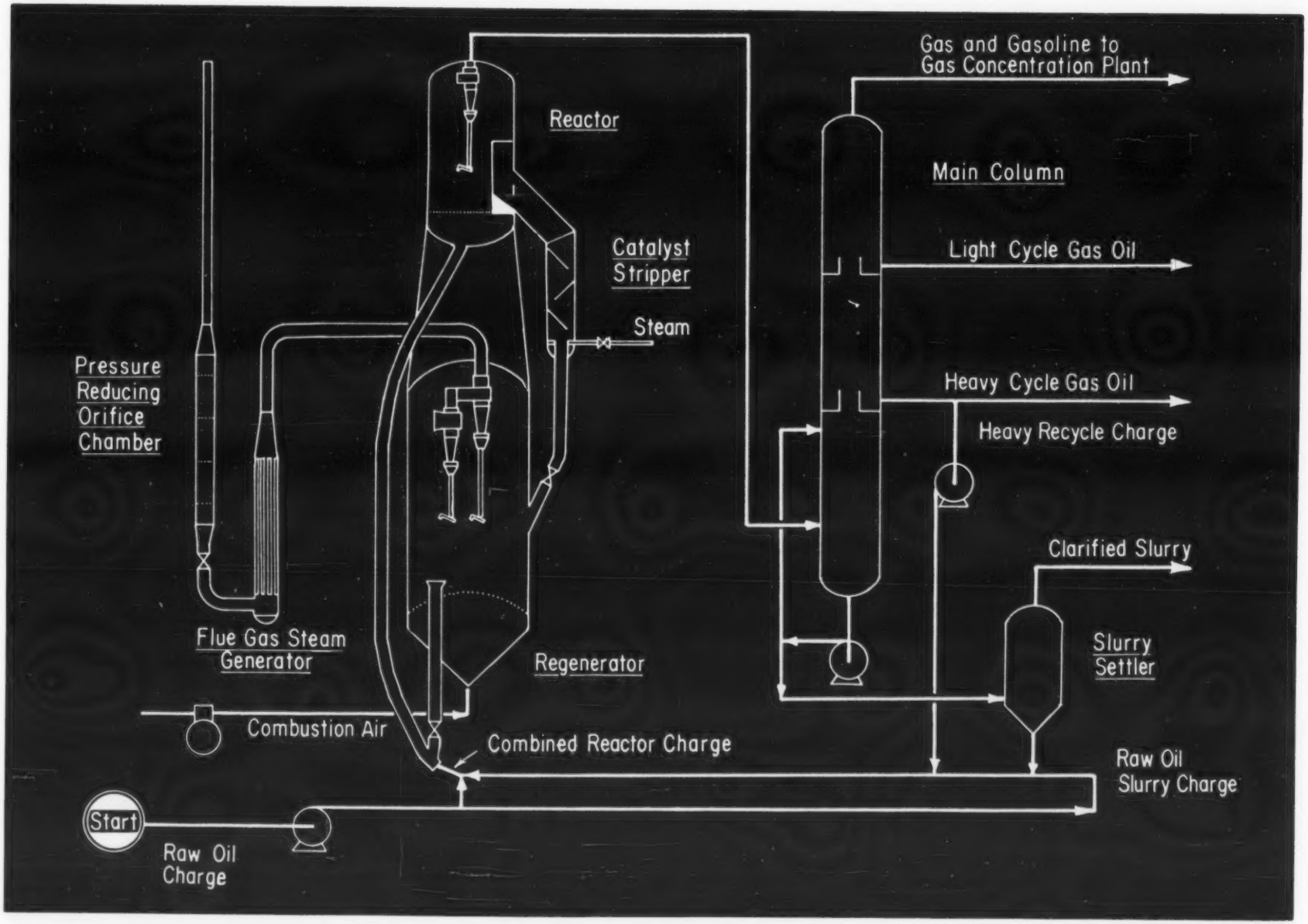
The design of this unit imparts particular flexibility. The unit can handle a rather wide range of catalyst-to-oil ratios to suit individual process requirements. It can process a totally liquid feed, provision is made to change reactor space velocity at will, reactor temperature can be varied over a wide range and a high octane product is produced. Moreover, installation and operating costs are low. Approximately 90 percent of the heat generated by burning off the catalyst is recovered in maintaining reactor temperature and by steam generation.

Yields: Typical yields when cracking a 28° API Mid-Continent gas oil in once-through and recycle operations are given in the table.

Commercial Installations: UOP-designed fluid cracking units in operation or under construction range in size from 1,200 to approximately 35,000 bpsd of fresh feed.

Reference: PETROLEUM REFINER, No. 3, 130 (1951).

OPERATION	Once Through	Recycle
Conversion	60	75
Yields (Volume Percent):		
Debutanized Gasoline	45.2	53.5
Light Cycle Oil	28	21
Heavy Cycle Oil	12	4
Butylenes	5.9	8
Butanes	6.4	8
Propylene	5.0	6.4
Propane	2.9	3.7
C_2 and Lighter Gas, Wt. Percent	2.2	2.8
Octanes, 10-Psi RVP Gasoline:		
F-2 O.N. Clear	81.5	81.5
+ 3 ml. TEL	86.5	86.5
F-1 O.N. Clear	93.5	93.5
+ 3 ml. TEL	98.5	98.5
Yields with Polymerization (Volume Percent):		
10 Psi RVP Polymer Gasoline	7.6	10.0
10 Psi RVP Catalytic Cracked Gasoline	47.6	56.4
Total 10 Psi RVP Gasoline	55.2	66.4


Gas and Gasoline to
Gas Concentration Plant
Reactor
Main Column
Catalyst
Stripper
Light Cycle Gas Oil
Steam
Pressure
Reducing
Orifice
Chamber
Heavy Cycle Gas Oil
Heavy Recycle Charge
Clarified Slurry
Flue Gas Steam
Generator
Regenerator
Slurry
Settler
Combustion Air
Combined Reactor Charge
Raw Oil
Slurry Charge
Start
Raw Oil
Charge

Fluid Catalytic Cracking, Model IV—

ESSO RESEARCH AND ENGINEERING COMPANY

Application: Converts gas oils and deasphalted stocks to high octane motor gasoline and other distillate products. The process also gives good yields of isobutane and light olefins which can be used for alkylation, polymerization, synthetic rubber, and chemicals manufacture.

Charge: A wide variety of virgin and cracked feed stocks, ranging from light distillates to vacuum distilled gas oils and deasphalted oils. By varying feed stocks to meet changing market conditions, refiners can aproach the optimum utilization of their crudes at all times.

Product: High yields of motor gasoline with clear octane number of 80 to 85 Motor and 92 to 99 Research. Isobutane and light olefins for alkylation, polymerization, LPG, or synthetic rubber may be recovered.

Description: In Model IV Fluid Catalytic Cracking, reactor and regenerator vessels are mounted side by side at a low elevation. This alignment eliminates expansion and rotation joints, and results in minimum over-all height. As a result, structural steel and foundation costs are lower and mechanical construction is greatly simplified.

As shown in the drawing, catalyst is transferred from vessel to vessel at moderate velocities by means of U-bends. Slide valves for catalyst flow control are eliminated in the Model IV, thus further reducing over-all height. Elimination of these slide valves also contributes to longer allowable run lengths by removing a principal point of erosion. In place of slide valve control, a portion of the regeneration air is injected at varying rates into the riser of the spent catalyst U-bend. These changes in air rate vary the density in the riser, and thus cause changes in the flow rate between vessels, Catalyst circulation rates as high as 70 tons per minute have been achieved. Ability to circulate at such high rates permits the construction of heat-balanced units even in very large sizes.

The U-bend transfer system has proved to be very stable in periods of refinery upset. The catalyst in the U-bend not only acts as a seal between the vessels during normal operation, but also impedes reverse flow through these lines in the event of pressure surges. Model IV units return to stable operation as soon as pressures have been restored to normal levels.

A slide valve is provided in each U-bend to permit positive shutoff in case of emergency or serious upset. Since these slide valves are normally out of the path of flowing catalyst, they suffer no erosion, and assure a positive safe shutoff should it become necessary to isolate the vessels.

All of the spent catalyst, along with that part of the air used to control circulation, enters the regenerator through the spent catalyst riser. The remainder of the air necessary for combustion enters the regenerator through a grid. Because only cool air—and no catalyst—flows through the grid, it is possible to use a carbon steel grid and have no concern about erosion or warpage.

There are no inaccessible moving parts in a Model IV Cat Cracker. In fact, there are no moving parts at all, except the air blower, the feed pumps, and, of course, the pumps and gas compressor in the product recovery section. This absence of moving parts in locations of critical wear contributes to low maintenance costs and short turnaround times.

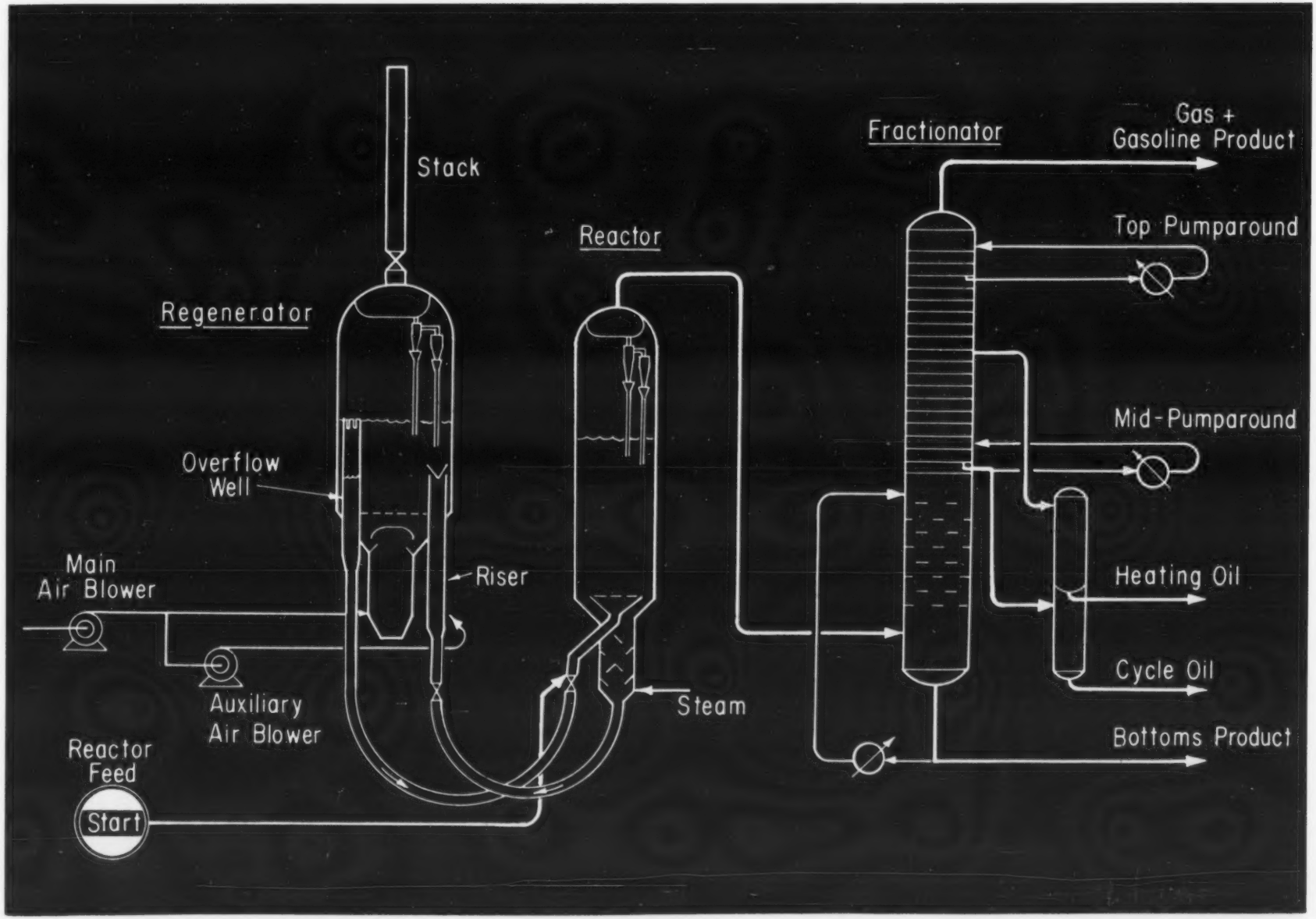
Commercial Installations: The first commercial Model IV unit was a 15,000 bpd unit put into operation at Destrehan, La. by Pan-Am Southern Corporation (now American Oil Company). At present, the total throughput capacity of the Model IV units in operation and under construction is nearly three-quarters of a million barrels per day. As indicated in the table, the individual units have a capacity range of more than tenfold, from smallest to largest.

Reference: PETROLEUM REFINER 35, No. 4, 201 (1956).

MODEL IV FLUID CATALYTIC CRACKING UNITS
(Operating or Building)

COMPANY	Location	Capacity Total Feed BPSD	Initial Operation
American Oil Co.*	Destrehan, La.	Shut Down	1952
Imperial Oil Ltd.	Edmonton, Alberta	14,800	1952
Imperial Oil Ltd.	Sarnia, Ontario	29,200	1953
Cie. Francaise de Raffinage*†	La Mede, France	14,740	1953
Esso Std. S.A.F.†	Port Jerome, France	15,400	1953
Esso Belgium, S.A.†	Antwerp, Belgium	10,800	1953
Esso Standard†	Everett, Mass.	30,000	1953
International Refineries, Inc.*†.	Wrenshall, Minn.	5,000	1953
Imperial Oil Ltd.	Ioco, Brit. Col.	12,600	1953
Lion Oil Co.*	El Dorado, Ark.	11,000	1953
Esso A.G.†	Hamburg, Germany	9,360	1953
American Oil Co.*	Texas City, Texas	30,000	1954
Standard Vacuum Oil Co.†	Durban, S. Africa	9,740	1954
Imperial Oil Ltd.	Regina, Sask.	15,300	1954
Standard Vacuum Oil Co.†	Bombay, India	9,360	1954
Standard Oil Co. of California	El Segundo, Calif.	61,000	1954
Empresa Col. de Petr.	Barrancabermeja, Col.	19,280	1954
Calif. Texas Oil Co., Ltd.*	Batangas, P.I.	10,800	1954
Calif. Texas Oil Co., Ltd.*	Yokohama, Japan	10,800	1954
Standard Oil Co. of B.C., Ltd.*	Vancovuer, Brit. Col.	9,000	1954
Salt Lake Ref. Co.*	Salt Lake City, Utah	8,000	1955
Calif. Texas Oil Co., Ltd.*	Kurnell, Australia	30,000	1955
Cie. Francaise de Raffinage*	Le Havre, France	30,000	1956
Imperial Oil Ltd.	Halifax, Nova Scotia	34,000	1956
Standard Vacuum Oil Co.†	Wakayama, Japan	20,000	1956
Calif. Texas Oil Co., Ltd.*	Visakhapatnam, India	14,700	1957
Standard Oil Co. of Texas*	El Paso, Texas	30,000	1957
Esso Standard S.A.F.	Port Jerome, France	23,150	1957
Standard Vacuum Oil Co.	Palembang, Sumatra	22,500	1957
Int. Petroleum (Colombia), Ltd.	Cartagena, Colombia	25,000	1957
Esso Standard Oil, S.A.	Belot, Cuba	24,000	1958
Petroleos Mexicanos	Atzcapotzalco, Mexico	25,000	1959
Standard Oil Co. of California*	Richmond, Calif.	55,000	1959
Esso S.A.P.A.†	Campana, Argentina	16,050	(1960)
Petroleos Mexicanos*	Madero, Mexico	25,000	(1960)
Irving Refining Co., Ltd.*	St. John's, New Brunswick	13,300	(1960)
Standard Oil Co. of Claifornia*	Honolulu, T.H.	22,000	(1961)
		745,880	

* Licensee.
† Combination Unit.


Stack
Reactor
Fractionator
Gas +
Gasoline Product
Top Pumparound
Regenerator
Mid-Pumparound
Overflow
Well
Riser
Main
Air Blower
Heating Oil
Cycle Oil
Auxiliary
Air Blower
Steam
Bottoms Product
Reactor
Feed
Start

Fluid Catalytic Cracking, Orthoflow — THE M. W. KELLOGG COMPANY

Application: For the selective conversion of petroleum fractions boiling above the saleable distillate range, to valuable light olefins, high-octane gasoline, and No. 2 fuel oil.

Charge: Atmospheric and vacuum gas oils, visbreaker and coker gas oils, decarbonized oil and, in certain cases, whole reduced crude.

Product: High-octane gasoline (frequently split into light gasoline for premium and super-premium and heavy gasoline for regular blends), furnace or diesel oil blend stock, olefins and isobutane for alkylation, butane and dry gas.

Description: The Orthoflow design, developed and licensed by The M. W. Kellogg Company, provides straight-line flow of catalyst between the vessels, virtually eliminating erosion normally encountered in pipe bends.

The Orthoflow principle has been developed in two alternative forms, both in successful commercial operation. In one system (A) the regenerator is located beneath the reactor and in the other (B) it is positioned above the reactor. Both systems have economic applications, the choice depending upon local cost factors. Both realize a unique degree of simplicity of construction, operation and maintenance.

A simplified flow diagram of the Orthoflow (B) Fluid Catalytic Cracking Process is shown on the opposite page.

Fresh gas oil feed and recycle from the fractionator enter the base of the reactor through a distribution system. Hot regenerated catalyst flows downward through standpipes, contacts the oil vapors, and is carried up into the reaction zone in sufficient quantity to maintain the reaction temperature. A catalyst bed level is established in the reactor to give the required space velocity. Oil vapors from the cracking reaction are separated from entrained catalyst in internal cyclones and carried to the fractionator.

The spent catalyst stripping zone is positioned centrally within the reactor. Stripped spent catalyst is conveyed upward to the regenerator section with a portion of the regeneration air, which is admitted through the hollow stem of the spent catalyst plug valve. In the regenerator the spent catalyst is contacted with additional air to reduce the carbon content to the desired level. Internal cyclones are used to separate regenerated catalyst from the flue gas stream leaving the top of the regenerator.

In the fractionator, the reactor effluent is separated into gasoline, light gas oil, a recycle stream, and a slurry stream. The recovery consists of absorption and distillation towers to produce gasoline fractions as required and olefinic feed stock for catalytic polymerization or alkylation.

Through the construction of the reactor and the regenerator in a single vessel and the use of straight internal catalyst carrier lines, the Orthoflow represents the simplest design to date. One of the major design achievements was the development of plug valves which regulate internal catalyst flow. These valves eliminate the need for expansion joints in many instances and are more easily maintained than conventional slide valves. The operating history of Orthoflow units has been remarkably free of erosion difficulties. The rate of erosion of the plugs is considerably less than with slide valves and, unlike slide valves, the plugs inherently compensate for wear without loss of control.

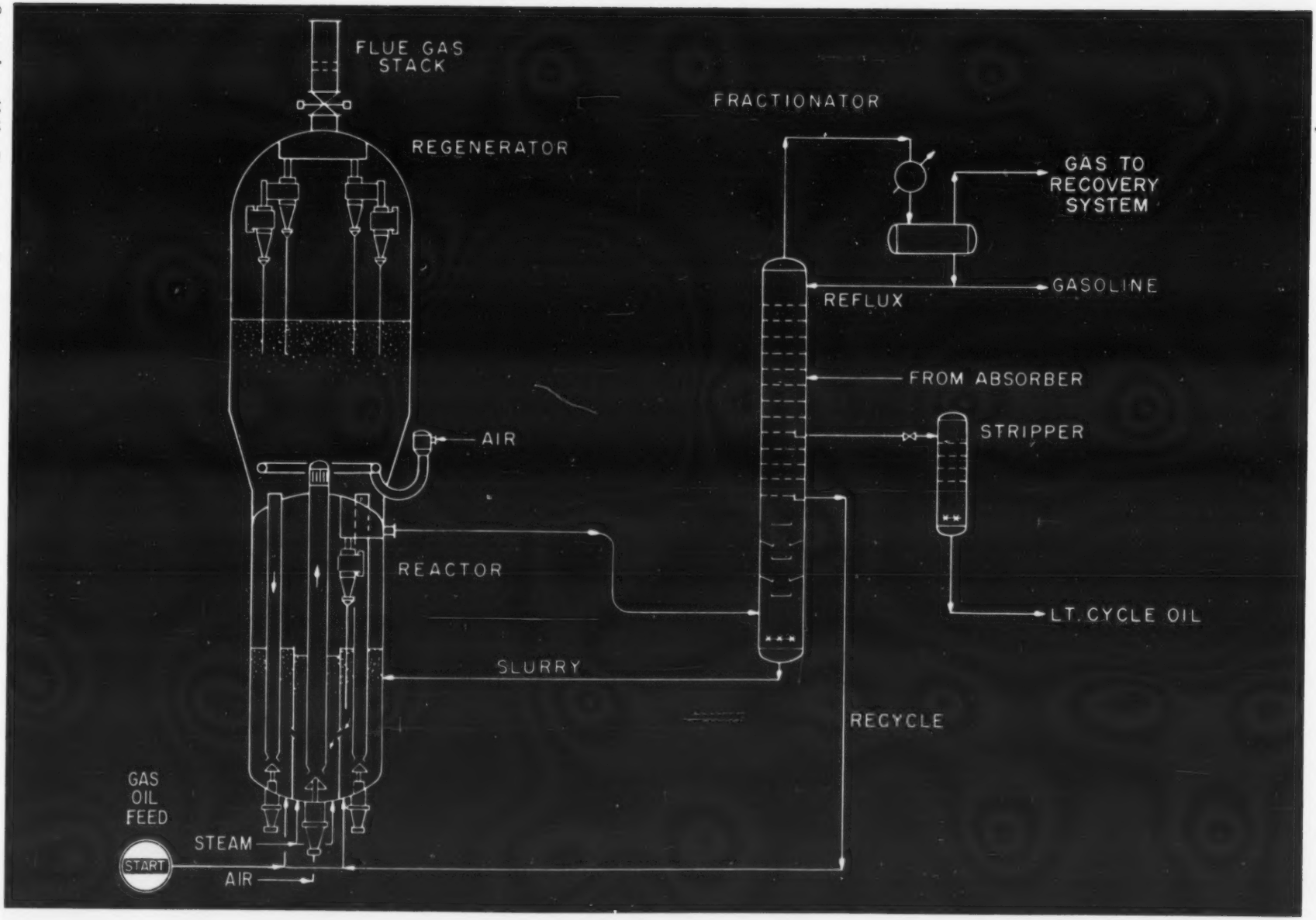
Operating Conditions:

Reactor Temperature	885-950 F.
Reactor Pressure	14-24 psig
Regenerator Temperature	1050-1150 F.
Regenerator Pressure	8-15 psig
Catalyst/Oil Ratio	7-12 C/O
Space Velocity	1.0-3.0 W/Hr./W.

Yields: Typical Yields from an Orthoflow F.C.C.U.

Charge Gravity, °A.P.I.	28.0
Throughput ratio	1.5
Conversion, volume percent	70.8
Tail gas, weight percent	7.8
C_3 to poly, weight percent	6.9
C_4 + gasoline, volume percent	58.0
Light cycle oil (No. 2 fuel), volume percent	23.5
Debutanized gasoline:	
Gravity, °A.P.I.	58.0
R.V.P., psi	7.0
50 percent point, °F	210
End point, °F	420
F-1 O.N., Clear	93
F-1 O.N., + 3cc TEL/Gal.	99

Commercial Installations: At present 23 units of the Orthoflow design are operating or in various stages of completion.


FLUE GAS STACK
REGENERATOR
FRACTIONATOR
GAS TO RECOVERY SYSTEM
GASOLINE
REFLUX
FROM ABSORBER
STRIPPER
AIR
REACTOR
LT. CYCLE OIL
SLURRY
RECYCLE
GAS OIL FEED
STEAM
START
AIR

Fluid Catalytic Cracking, Two Stage—SHELL DEVELOPMENT COMPANY

Application: For providing higher gasoline and lower coke yields while permitting greater flexibility for shifting production between maximum gasoline and maximum intermediates.

Charge: Conventional catalytic cracking feed stocks.

Products: Conventional, but with different distribution.

Description: The flow pattern for the process is shown in the accompanying diagram. The feed and hot regenerated catalyst travel concurrently up through a riser. This riser comprises the first-stage reactor in which the retention time is very short. The material from the riser passes into a high-load separator where the partially spent catalyst is removed from the products of the first stage cracking. The latter are sent to a fractionator to remove products that would be destroyed or adversely affected by subsequent cracking.

The unconverted and insufficiently converted hydrocarbons are removed from the fractionator as bottoms and sent to the second-stage reactor. Here the partially spent catalyst again contacts the hydrocarbons and additional cracking is achieved. The vapor from the second-stage cracking is separated by fractionation into the various boiling range products. The spent catalyst is passed to a regenerator and then recycled back to the first-stage reactor.

The Two-Stage Fluid Catalytic Cracking process is used to achieve optimum yields from various feed stocks. When cracking is carried out in one stage, the least refractory components are cracked too severely and yield large amounts of gas and coke while the more refractory components undergo only low conversion. This overcracking and undercracking prevents the realization of optimum yields.

The first-stage reactor is operated at high temperatures so that the coke yields are kept low. This condition would have the disadvantage of destructively cracking some of the gasoline components of the charge, if it were not for the very short retention time. By sending the effluent from the first-stage reactor to a fractionator, the components that might otherwise be overcracked can be removed from the cracking zones. The more refractory materials can then be given a longer, more thorough cracking in the second-stage reactor.

The catalyst for the second-stage operation is supplied from the first-stage separator. The partially used condition of this catalyst does not hamper the second-stage cracking.

In the two-stage cracking process, considerable flexibility is available for changing the yield structure from a given feed stock. For example, gasoline yield can be increased further by incorporating recycle into one of the cracking stages. On the other hand, in periods of high demand for intermediates, the yield of light gas oil may be increased substantially by charging only heavy gas oil to the second-stage reactor.

Application of the principles described here is not limited to new installations. Existing fluid units can, in some instances, be modified to take advantage of the short-contact-time and the two-stage principles by addition of a riser reactor and accompaning facilities. In cases where high conversion is not required, a single-stage riser reactor unit may be designed to take advantage of the increased selectivity.

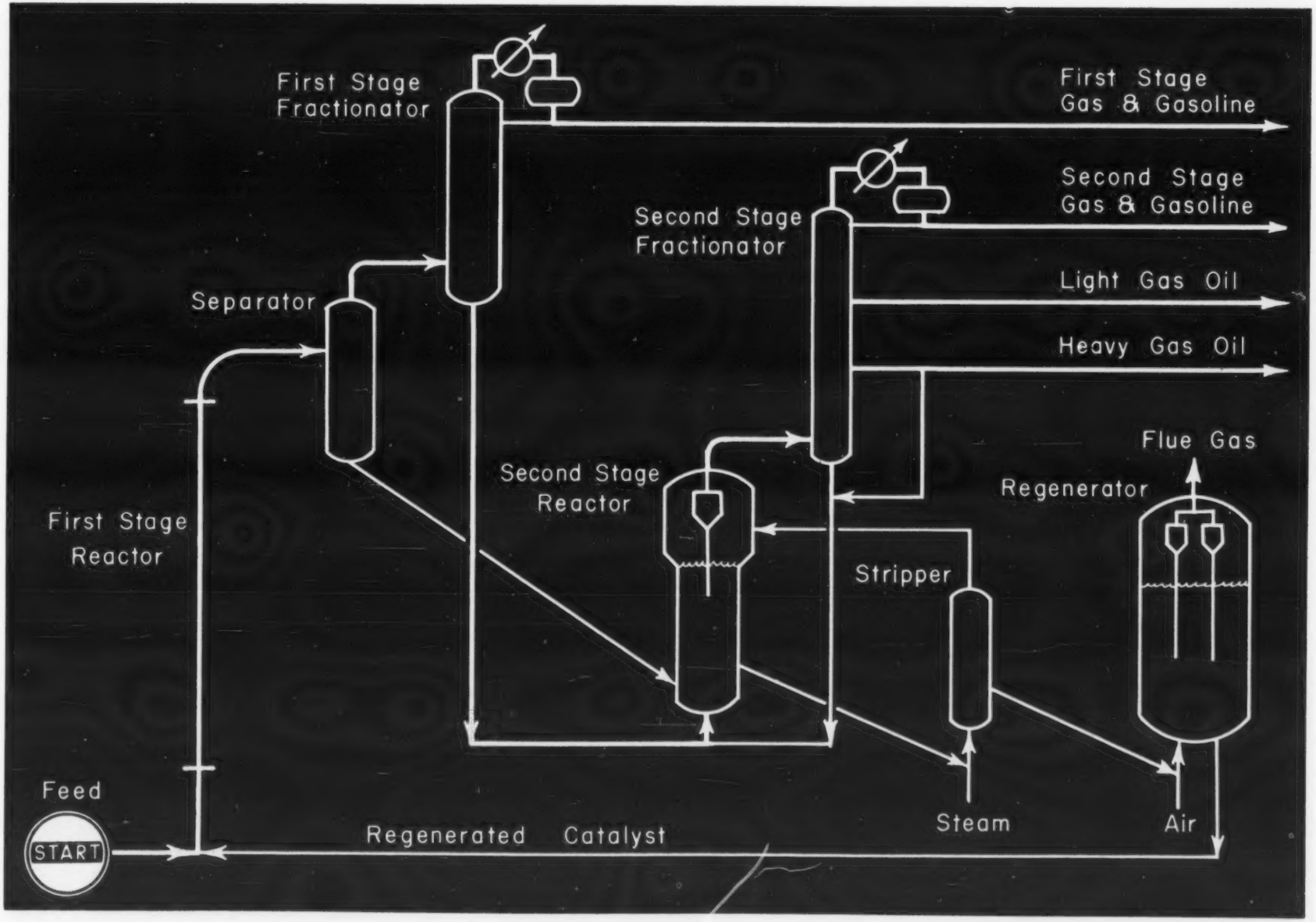
Yields: Typical results of commercial operation with feeds prepared from Alberta, Ventura, and Four Corners crudes are given in the following table:

Feed Stock and Yields for Commercial Two-Stage Catalytic Cracking

TYPE OF FEED STOCK	Alberta		Ventura		Four Corners
	I	II	I	II	I
Charge Rate, B/D	19,958	29,865	20,522	17,899	21,257
Feed Stock Properties					
Gravity, API	26.5	27.1	25.0	24.5	28.6
Engler Distillation, ° F.					
IBP	505	500	457	436	400
10 vol. %	610	575	565	550	473
Pour Point, ° F.	+65	+70	+70	+75	0
Ramsbottom Carbon Residue, wt. %	0.82	0.69	0.39	0.59	0.60
Sulfur, wt. %	0.80	0.75	0.86	0.78	0.39
Cracking Yields vol. %					
Ethane and lighter (wt. %)	3.8	3.3	4.9	6.2	3.2
Propylene	10.3	7.8	8.5	8.5	10.2
Propane	3.5	3.9	3.1	2.6	2.8
Butylenes	12.9	10.3	11.0	10.8	12.3
Isobutane	5.3	3.0	4.2	2.6	8.4
Normal Butane	1.2	0.7	0.8	1.3	1.3
Debutanized 450 ° F. Cut Point Gasoline	53.6	51.5	44.7	48.2	52.0
Light Gas Oil	11.3	18.2	15.5	10.8	11.0
Heavy Gas Oil	9.4	11.3	15.4	13.1	10.2
Coke (wt. %)	8.7	6.9	9.9	12.1	8.4
Gasoline, 10 RVP (psi incl. C_3 and C_4 Polymer)	75.6	67.1	62.8	66.4	73.0
Conversion, wt. %	78.6	69.9	69.6	74.7	78.1

Commercial Installations: The first commercial unit employing this new technique was built in Shell's refinery at Anacortes, Washington. This process is licensed by the Shell Development Company through Universal Oil Products and the M. W. Kellogg Company.

Reference: Proc. 5th World Petroleum Congress, Sect. III, 103 (June 1959).


First Stage
Fractionator
First Stage
Gas & Gasoline
Second Stage
Gas & Gasoline
Second Stage
Fractionator
Light Gas Oil
Heavy Gas Oil
Separator
Flue Gas
Second Stage
Reactor
Regenerator
First Stage
Reactor
Stripper
Feed
START
Regenerated Catalyst
Steam
Air

Houdriflow—HOUDRY PROCESS CORPORATION

Application: To produce high-octane motor and aviation fuels from a wide range of petroleum distillate fractions.

Charge: Liquid, vapor, or a mixture of both. At most of the plants the reactor feed is over 50 percent liquid, and in some cases is totally liquid. Feed may also consist entirely of accumulated cycle stock. Sweet and sour stocks, and any fractions of the crude boiling between naphtha and penetration asphalt, are handled with equal ease.

Product: Excellent yields of motor gasolines with octane values in the range of 88-94 F-1 clear (95-99 with 3 cc. TEL), depending upon charge stock, operating temperature, and catalyst used in the individual unit.

Description: The Houdriflow process is distinguished for its (a) ease of operation under normal and emergency operating conditions, (b) low maintenance and operating cost, (c) high catalyst activity in conjunction with low catalyst make-up cost, and (d) flexibility as to charge stocks handled and conversion levels attained.

A pneumatic lift system recirculates regenerated catalyst, which may be either natural or synthetic. The pneumatic lift was introduced in 1948, and this system supplanted the bucket-elevator catalyst lift.

The latest design can utilize a heat balance operation and thus eliminate the necessity for regeneration heat removal in the kiln by cooling coils.

The entire Houdriflow unit may be constructed compactly on a ground area 40 by 60 feet. The integrated catalytic reactor and regenerating kiln, comprising a single vessel, and the hot catalyst storage vessel, are self-supporting. They are customarily positioned on opposite sides of a steel structure housing a stairway and supporting the catalyst lift.

Operating Conditions: Normally within the following ranges: Temperature 850°-950° F; Pressure 9-10 psig; Space velocity 1.5-4 v/hr/v and Catalyst-oil ratio 3-7.

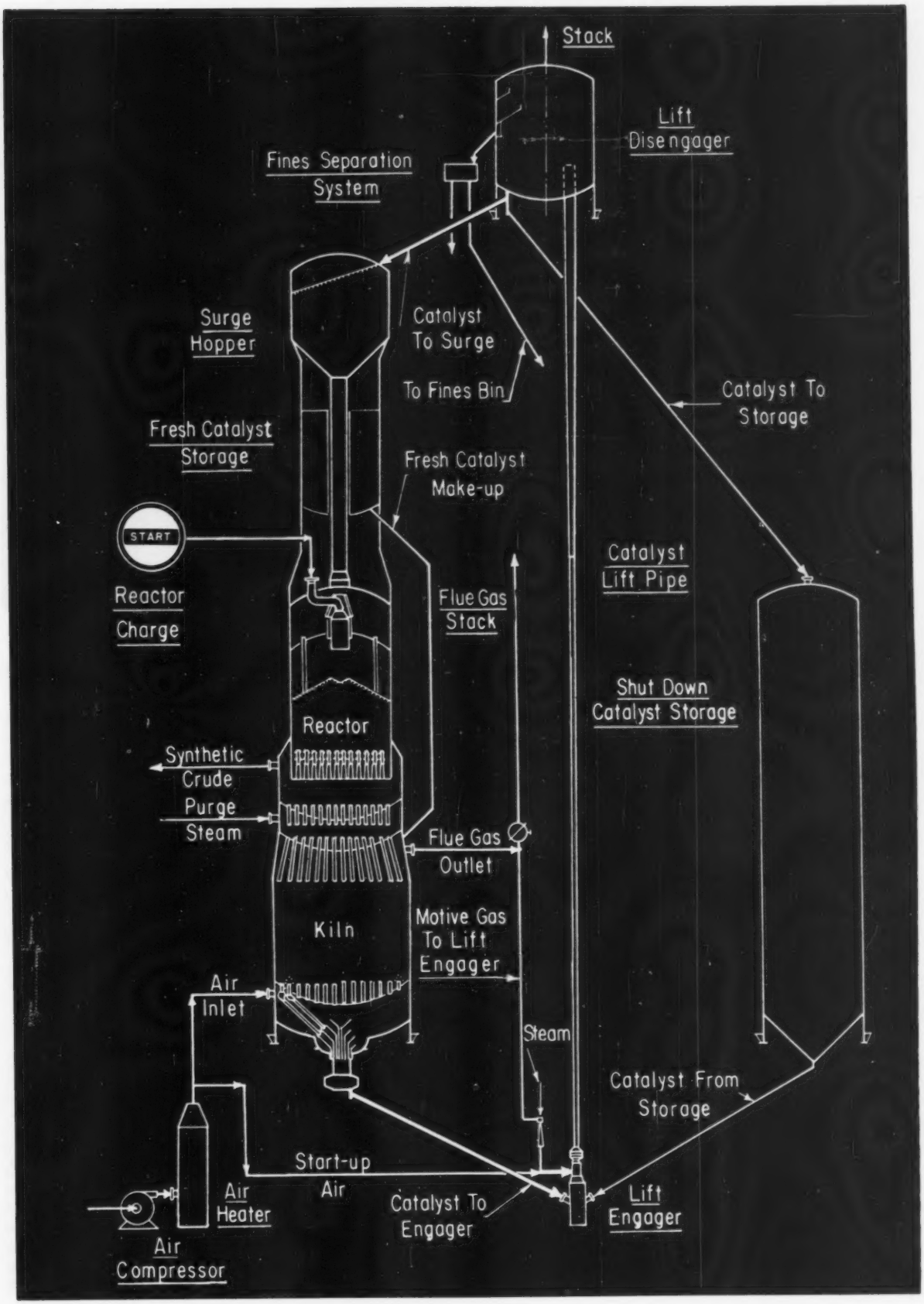
Yields: Conversion above 90 percent has been achieved in commercial operation with relatively low coke deposit, using recycle ratios of 1 to 1 or slightly more. Where once-through cracking is preferred, 50-60 percent conversion is obtained.

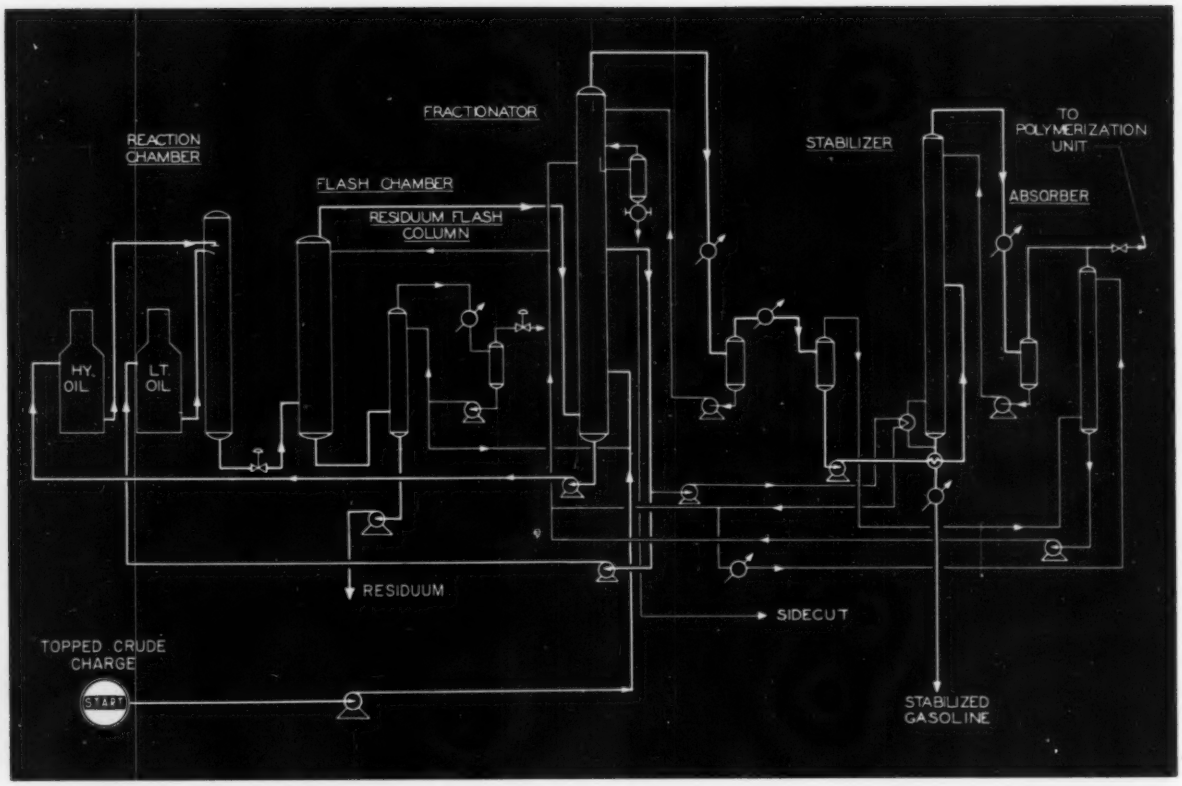
Commercial Installations: In the United States and abroad, 22 Houdriflow units have been licensed ranging in size from 2,000 bpsd to 27,000 bpsd design capacity. Total nominal design capacity of all Houdriflow catalytic crackers in operation and under construction is 280,430 bpsd.

Reference: PETROLEUM REFINER 31, No. 5, 133 (1952).

Charge Stock	A	B	C
Charge Rate, BPSD:[1]			
Virgin Gas Oil	5,810	4,460	4,750
First Pass Cat. Gas Oil	1,430	.....	.....
Recycle	.....	2,200	5,700
Total	7,240	6,660	10,450
Conversion	49.7	68.9	90.8
Products:			
Gasoline,[2] Volume Percent	40.8	53.7	67.8
Total Gas Oil, Volume Percent	50.3	31.1	9.2
C_3-C_4 Recovered, Volume Percent	16.1	18.6	25.0
Liquid Recovery, Volume Percent	107.2	103.4	102.0
Fuel Gas, Weight Percent	3.8	5.8	7.3
Catalyst Deposit, Weight Percent	5.2	5.4	9.0
Gasoline Octanes:			
F-1 Clear	91.5	90.6	89.3
F-1 + 3 cc TEL	.....	.....	96.7
F-2 Clear	81.7	.....	.....

[1] Charge stocks are atmospheric plus vacuum gas oils from: (A) Texas pipe line crude, (B) Scurry crude, and (C) Hutchinson-Moore, County, West Texas, crude.
[2] Gasoline basis: 10 psi RVP and 380° F at 90 percent distilled.


Stack
Lift
Disengager
Fines Separation
System
Surge
Hopper
Catalyst
To Surge
To Fines Bin
Catalyst To
Storage
Fresh Catalyst
Storage
Fresh Catalyst
Make-up
START
Reactor
Charge
Catalyst
Lift Pipe
Flue Gas
Stack
Shut Down
Catalyst Storage
Reactor
Synthetic
Crude
Purge
Steam
Flue Gas
Outlet
Kiln
Motive Gas
To Lift
Engager
Air
Inlet
Steam
Catalyst From
Storage
Start-up
Air
Air
Heater
Catalyst To
Engager
Lift
Engager
Air
Compressor



Thermal Cracking — UNIVERSAL OIL PRODUCTS COMPANY

Application: Produces gasoline from every variety of charging stock, from distillates to the heaviest crudes and residual oils.

Thermal cracking produces butylenes and propylene which can be polymerized to produce polymer gasoline of high octane number for use as a blending fluid to improve the quality of other gasolines, or used in alkylation.

Description: The ideal equipment for thermally cracking topped or reduced crudes is centered about the two-coil cracking unit designed for optimum results when producing high-grade cracked fuel oil residuum.

The topped or reduced crude charge is introduced to the side of the fractionating column where it is contacted with the vapors from the flash chamber. The overhead product from the fractionating column is end point gasoline. Furnace or tractor distillates are withdrawn as sidecuts and stripped to specifications. From a lower sidecut tray a higher boiling distillate comprising the lower boiling fractions of both the recycle and charging stocks is withdrawn as charge to the light oil heater. The charge to the heavy oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest boiling fractions of both the recycle and charging stocks.

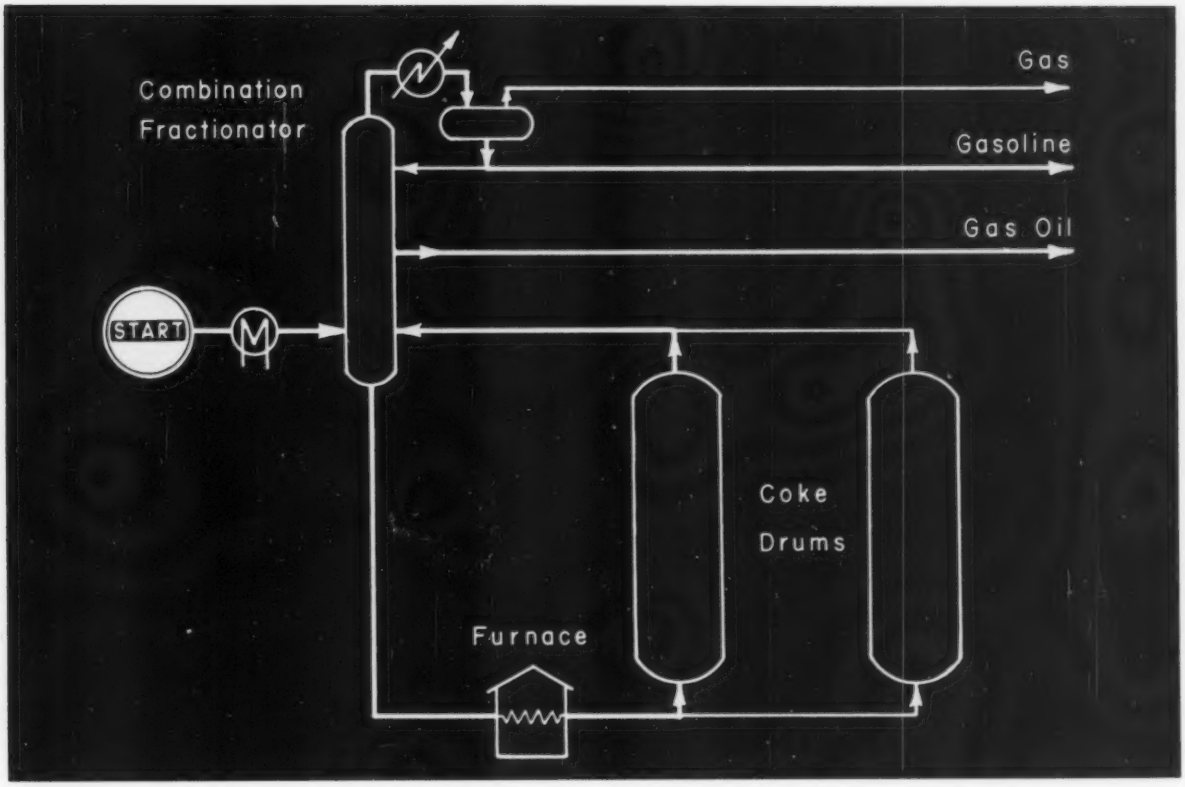
The transfer lines from the two heaters enter the top of a downflow reaction chamber. This chamber is operated without a liquid level, since all of the products are withdrawn from the bottom through a pressure control valve.

The mixture leaving the reaction chamber enters the flash chamber in which a fuel oil residuum of the desired properties is separated.

Yields: To illustrate the comparative results obtained in various methods of processing, the following yields are presented as representative results when charging a typical 25° API Mid-Continent reduced crude having a viscosity of 20 SFS at 122° F. In considering these results, it must be remembered that not only the gravity but also the viscosity of the charge is important in determining yields.

	Maximum Gasoline	Maximum Furnace Oil
Percent by Volume of Charge:		
Gasoline, 400 E.P., 10 RVP	53.5	38
Furnace Distillate		23
Fuel Oil	37.5	34
Liquid Volume Loss	9	5
Gas, Cu. Ft./Barrel	500	290
F-2 Octane Number, Clear	69–70	68–69
Fuel Oil, Viscosity, SFS at 122 F	200	200
Fuel, Oil Gravity, ° API	7	8
Percent Catalytic Polymer Gasoline 10 RVP	5	3.5
Percent Total Gasoline, including Polymer	58.5	41.5
F-2 Octane Number of Total Gasoline, Clear	71–72	70–71

It should be noted that the cracked gasoline yields are all reported on the basis of 400° F end point and 10 RVP. On the basis of total butane-butylene retention in the gasoline the yields would be increased approximately 4 percent respectively. The yields of catalytic polymer gasoline shown in the table are on the basis of polymerizing 80 percent of the propylene and butylenes formed in the cracking operation.



Coking

Application: To prolong cracking conditions so that the yields of gas oil and gasoline are increased.

Charge: Reduced crudes, cracked tars, heavy catalytic cycle oils, and asphalts.

Products: Gas oil, gasoline, gas and coke.

Description: The feed is heated and charged to the lower portion of a fractionator. Here the charge meets the hot vapors from the coking drum and light components are flashed from the crude.

The heavy residue passes from the bottom of the fractionator to a furnace where it acquires the heat of cracking. Then the heated residue is introduced into an insulated drum where the residence time is sufficient for coke to form and settle from the mixture.

The vapors from the coking drum return to the fractionator. Here the gas, gasoline and gas oil are separated and leave the unit. The heavier materials appear in the bottoms and are recycled to the coking operation.

When coke builds up to a predetermined level in one of the coke drums, flow is diverted to another drum so that the furnace operation is continuous. Thus drums are operated in pairs with one on-stream while the other is being dumped.

A full coke drum is removed from the process flow, steamed to strip light hydrocarbons from the coke, and cooled by water injection. More recent designs use high pressure (over 1,000 psig) water jets to cut the coke from the drum.

Operating Conditions: The normal range of operating conditions for which coking units have been designed are as follows:

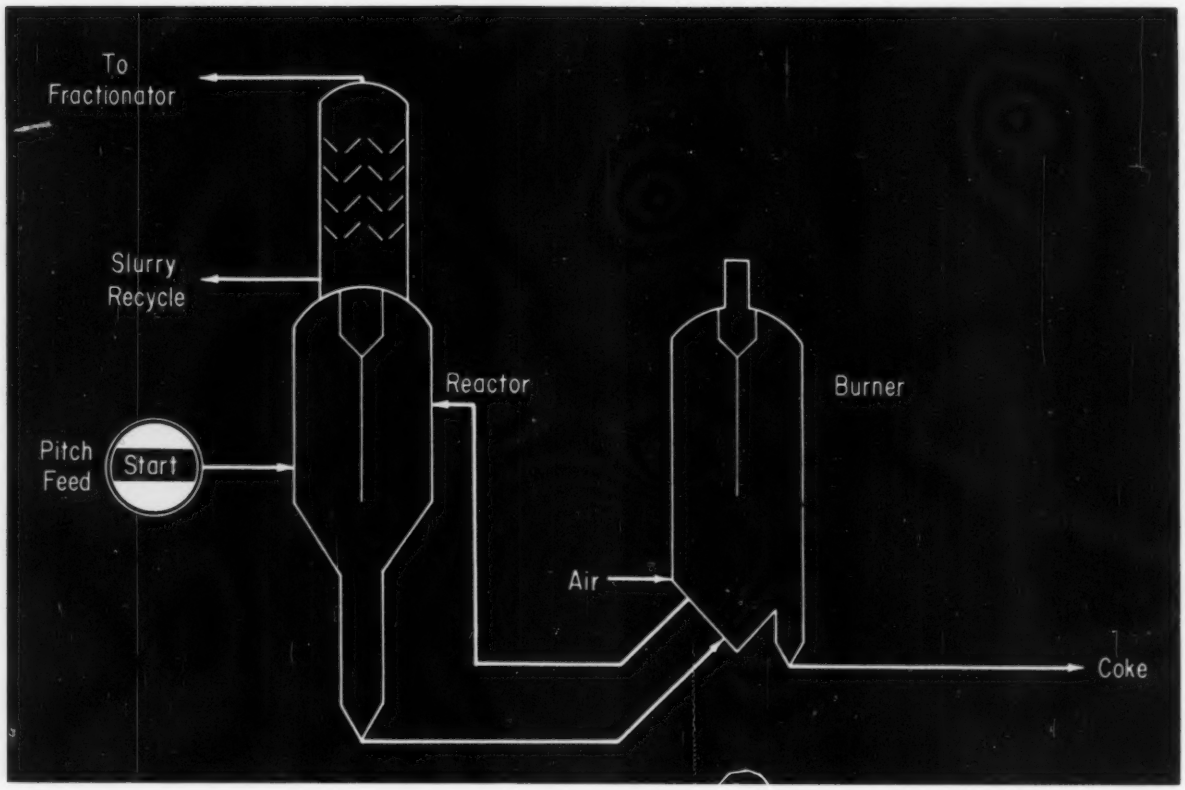
Furnace Outlet Temperature	900°-940° F
Coke Drum Temperature	780°-840° F
Coke Drum Pressure	10-70 psig

Yields: There is a wide variation in the product distribution depending on whether gasoline is to be produced during the coking operation or during subsequent cracking of the coker gas oil. Gasoline yields may be from 5 to 25 volume percent of the charge to the coking unit.

Commercial Installations: In the U.S. and Canada there exists drum coking capacity to process about 500,000 barrels of feed per day. This is equivalent to about 16,500 tons of coke per day.

Reference: Coking units are designed and installed by several companies under various names. Process descriptions and yield data for most of these designs have been published in the PETROLEUM REFINER. Reference to these descriptions are given in the following table.

Process Name	Company	Reference: PETROLEUM REFINER
Decarbonizing	Blaw-Knox Co.	32, No. 7, p. 106 (1953)
Delayed Coking	Foster Wheeler Corp.	31, No. 9, p. 148 (1952)
Delayed Coking	The M. W. Kellogg Co.	32, No. 7, p. 108 (1953)
Delayed Coking	The Lummus Co.	38, No. 6, p. 169 (1959)
Delayed Coking	Union Oil Co. of California	34, No. 7, p. 149 (1955)
Low Pressure Coking	Universal Oil Products Co.	33, No. 2, p. 157 (1954)



Fluid Coking— ESSO RESEARCH AND ENGINEERING COMPANY

Application: Upgrades a wide range of low-value residual stocks to gasoline, middle distillates, catalytic cracking feed stock, and by-product gas and coke.

Charge: Whole crudes, atmospheric residua, heavy vacuum residua, or asphalts. In fact, this process can handle any pumpable hydrocarbon feed stock which contains more than about 5 weight percent Conradson Carbon residue.

Products: Naphtha, gas oils, coke, and light gases. Clear Research Octane Number of debutanized coker naphtha is in the range of 75 to 85. Gas oils produced in Fluid Cokers are used as feed stock in fluid catalytic cracking, moving-bed catalytic cracking, and thermal cracking units. The final boiling point of the liquid products from a Fluid Coker may be varied between 800° and 1,050° F. The C_4 stream is used as part of the feed stock for alkylation units. The product coke is used in electrodes for aluminum manufacture, in silicon carbide manufacture, in briquettes, in ore sintering operations, and as boiler fuel.

Description: The equipment is similar to that employed in fluid catalytic cracking, but operates with coarser noncatalytic solids. Small particles of petroleum coke, formed in the process itself, circulate in a fluidized state between the major vessels and act as a heat transfer medium.

Fluid Coking requires no preheat furnace or elaborate mechanical equipment for handling of product coke. The process operates at essentially atmospheric pressure and at temperatures of 900° to 1,050° F. The product coke can be transported to storage as a fluid in closed pipes.

Fluid Coking is truly continuous. Runs of 10 months or more without interruption or maintenance work have been achieved on several units. In one unit, a continuous run of more than 19 months' duration has been achieved.

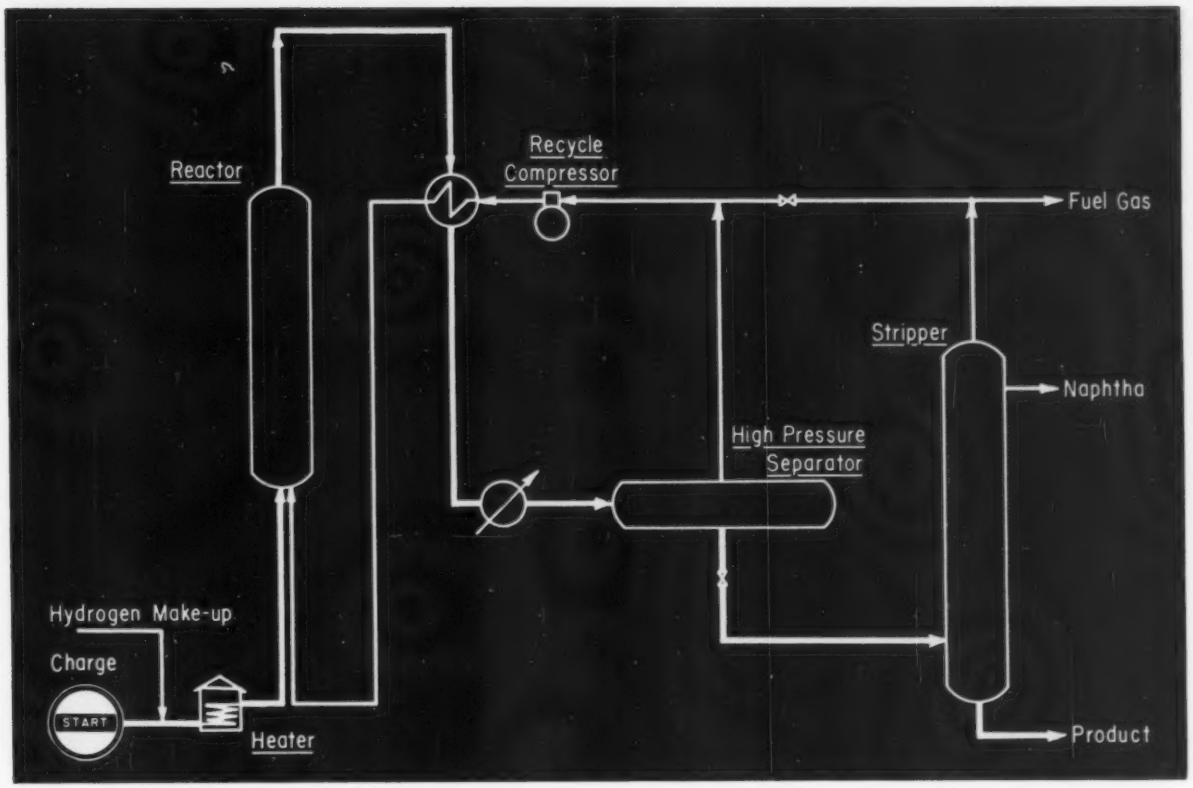
Recent engineering studies have led to the Model II Fluid Coker design. This design retains all of the process flexibility of the present units but investment and operating costs are substantially lower than that of the prototype units.

Yields: Fluid Coking yields vary widely with the characteristics of the feed stock and with the type of operation employed. For a given feed stock, the Fluid Coking process makes less coke and more liquid products than other coking processes. The final boiling point of the heaviest liquid product can be changed by as much as 200° F by adjusting operating conditions on the unit. The C_3 and C_4 fractions normally contain about 60 to 75 percent unsaturates.

Reference: PETROLEUM REFINER 39, No. 5, 157 (1960).

COMMERCIAL FLUID COKING UNITS

Company	Location	Capacity BPSD	Initial Operation
Carter	Billings, Mont.	3,800	1954
Esso Standard	Baltimore, Md.	Shut Down	1955
Canadian Petrofina, Ltd.	Montreal, Quebec	3,800	1956
Aurora Gasoline Co.	Detroit, Mich.	4,000	1956
Tidewater Oil Co.	Avon, Calif.	42,000	1956
Tidewater Oil Co.	Delaware City, Del.	42,000	1957
Signal Oil & Gas Co.	Bakersfield, Calif.	4,000	1957
Pontiac Eastern Corp.	Hattiesburg, Miss.	4,800	1957



H-Oil — HYDROCARBON RESEARCH, INC.

Application: For desulfurization, nitrogen removal, olefin saturation and stability improvement. The process, slightly modified, is also used on all types of heavy residuum stocks.

Charge: Light and heavy gas oils, catalytic cycle stocks, coker gas oils.

Products: Under non-hydrocracking conditions, about 100 volume percent of product is obtained containing a low content of sulfur, nitrogen, oxygen, unsaturates and metals. A varying amount of aromatic saturation is obtained depending on charge stock and process conditions. On heavy gas oils at hydrocracking conditions, about 101-103 volume percent of product is obtained with a 2/1 to 5/1 ratio of furnace oil to naphtha.

Description: Preheated hydrogen and oil are fed upward into the reactor where they are contacted with the catalyst in an ebulliting bed. The equipment downstream is as shown in the schematic flowsheet.

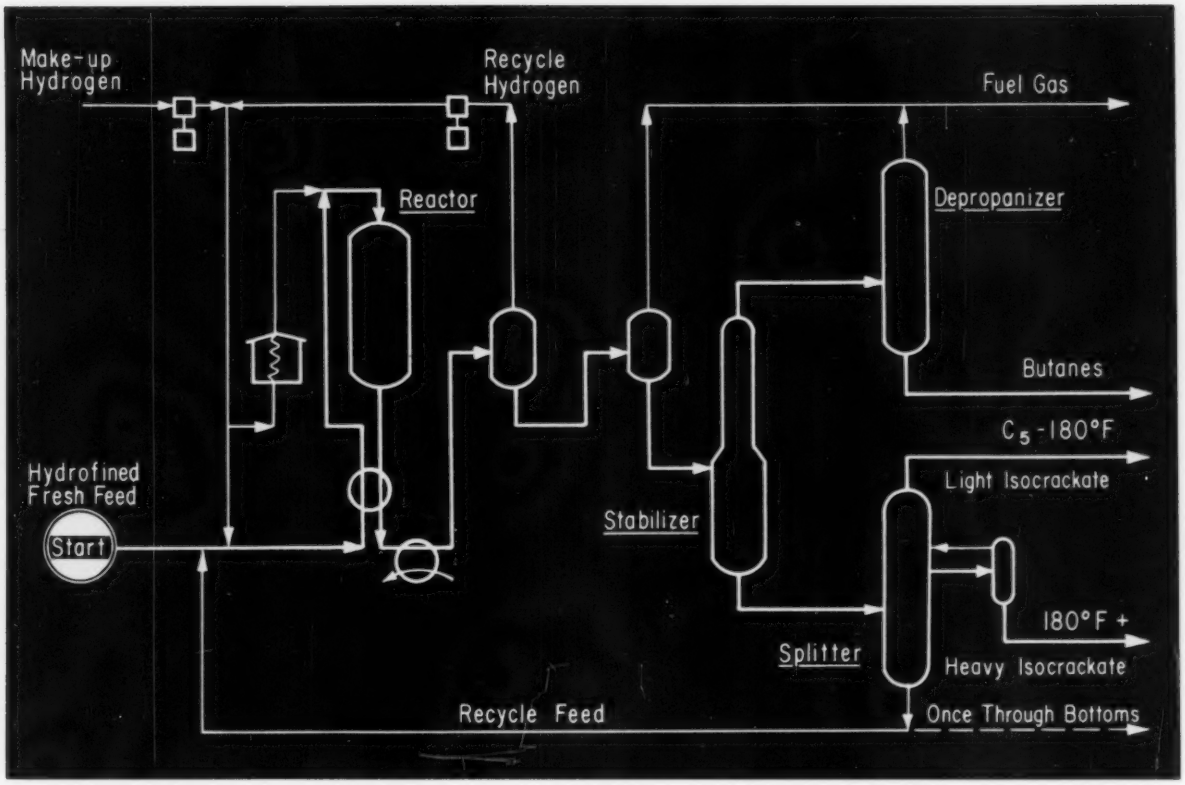
Active catalyst of relatively small particle size is employed so that reactor size and charged quantity of catalyst are small. The catalyst is "continuously" replaced as required, minimizing net consumption, avoiding unit downtime and eliminating "swings" in product quality. The ebulliting bed provides freedom from pressure drop problems both with respect to initial design and with respect to scaling, corrosion and carbon formation. Poor liquid distribution and localized catalyst overheating are eliminated.

Operating pressures of the process may be from 750 to 1,500 psig. Benefits of 1,500 psig operation are outstanding in some cases. Space velocities as high as 30 vol./hr./vol. may be employed when minimal cleanup is required. Catalyst make-up rates are very low; regeneration facilities are unnecessary, and downtime for in situ regeneration is avoided. At 1,500 psig, nitrogen removal, color and stability are more satisfactory for a given extent of desulfurization than at 750 psig. Designed at the higher pressure, the furnace oil unit is flexible with respect to block operation with heavier feeds.

Yields: The accompanying table provides typical yields at non-hydrocracking conditions.

	Light Coker Gas Oil		Heavy Coker Gas Oil		Kuwait Heavy Gas Oil	
	Feed	Product	Feed	Product	Feed	Product
Gravity	34.2	39.1	18.7	24.6	24.1	28.7
Distillation, °F						
IBP	350	284	366	286	510	288
10%	398	374	628	534	637	600
% to 600° F	94	93	10	20	5	10
Sulfur, W %	1.57	0.022	2.74	0.37	2.22	0.34
Nitrogen, W %	0.057	0.012	0.23	0.17	0.096	0.072
Aniline Point, °F	119	136	134	144	183	190
Metals, ppm						
Vanadium	....	....	1.2	~0.05	~0.1	~0.01
Nickel	....	....	0.24	~0.05	~0.1	~0.01
Characterization Factor	....	....	11.1	11.5	11.7	12.0

Reference: PETROLEUM REFINER 36, No. 9, 210 (1957).



Isocracking — CALIFORNIA RESEARCH CORPORATION

Application: (1) Converts hydrocarbon distillates to new high octane gasoline having low sensitivity, (2) produces jet fuel and isobutane as major by-product streams while converting gas oil stocks to gasoline, (3) improves gasoline quality including F-2 octane increase and volatility control, (4) improves distillate fuel quality including pour point reduction and cetane number improvement, (5) improves catalytic cracker efficiency, (6) gives bunker fuel oil reduction.

Charge: Gas oil distillates. The feed is hydrofined for removal of non-hydrocarbon impurities.

Products: Liquid yields from Isocracking are high, typically 115 to 120 volume percent C_4-plus material. Very low methane and ethane fuel gas yields and higher than equilibrium proportions of isoparaffins in the butane and pentane fractions are characteristic. The light Isocrackate characteristically has an F-1 and F-2 leaded octane rating of 99 to 100 irrespective of the type of charge stock. The heavy Isocrackate is a premium catalytic reformer charge. Products boiling above 400° F tend to be more paraffinic than feed and with proper fractionation will make excellent jet fuel.

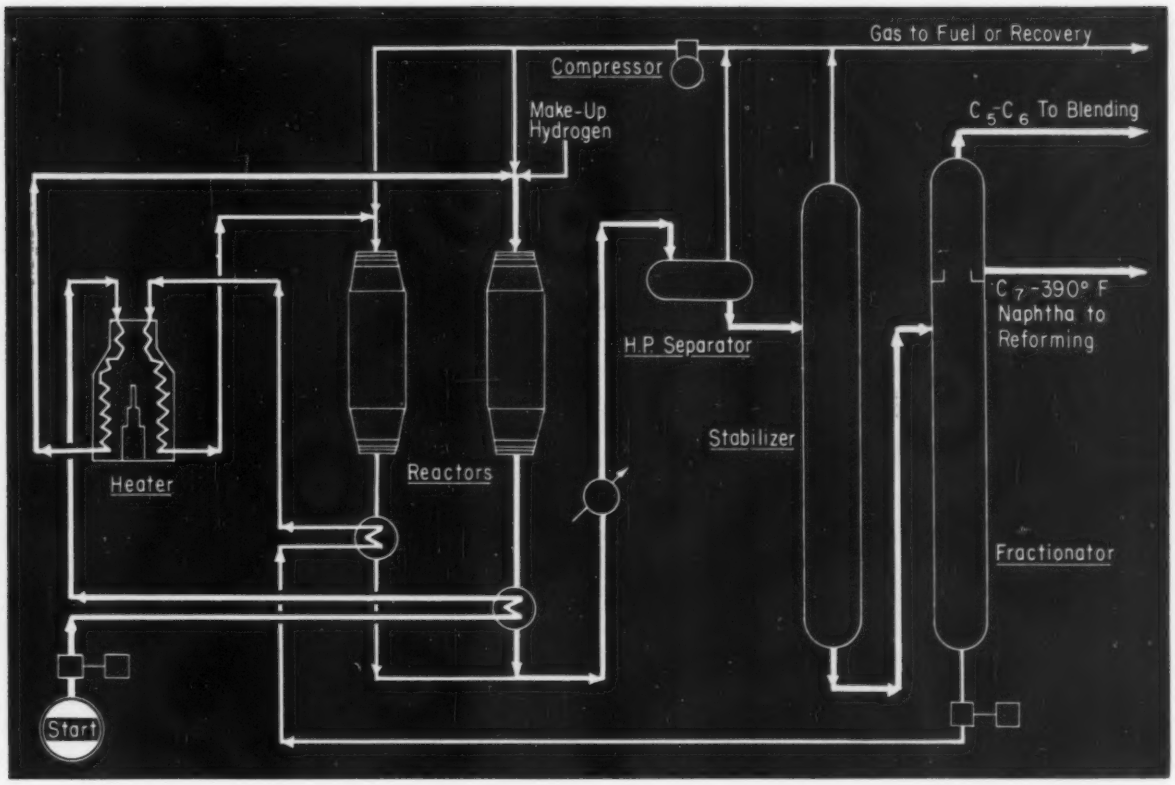
Description: Isocracking is low-temperature low-pressure hydrocracking. Operation is flexible. The plant can run to extinction recycle with variable product end point or to 60-80 percent per pass conversion on a once-through operation to make gasoline plus upgraded middle distillates. The hydrofined feed stock is heated by feed-product exchange and enters the reactor at desired temperature. The reaction is exothermic and cooling is employed to maintain a constant per pass conversion level. Product fractionation can be handled in a number of different ways.

Operating Conditions: The operating pressure for Isocracking ranges from 500 to 1,500 psig. Temperatures range from 400° to 700° F. Hydrogen consumption ranges from under 1,000 up to about 1,800 scf/b.

Typical Yields	Light Catalytic Cycle	Light Coker Distillate	S.R. Gas Oil
Feed			
Gravity, °API	26.0	24.8	29.1
Aniline Point, °F	111	80	177
Boiling Range, °F	400—650	350—610	585—725
Products, V%			
Isobutane	11.4	14.0	8.3
n-butane	5.9	6.1	3.2
C_5—180° F	27.1	28.5	22.2
180—400° F	78.3	72.8	.....
180—360° F	.....	.....	56.3
360—500° F	.....	.....	30.8
Total	122.7	121.4	120.8

Commercial Installation: The first commercial unit was placed on stream in Socal's Richmond refinery in July 1959.

Reference: PETROLEUM REFINER 39, No. 4, 155 (1960).



Lomax—UNIVERSAL OIL PRODUCTS COMPANY

Application: Conversion of light distillates into gasolines and heavier distillates (including vacuum gas oil) into high quality middle distillates and/or gasoline.

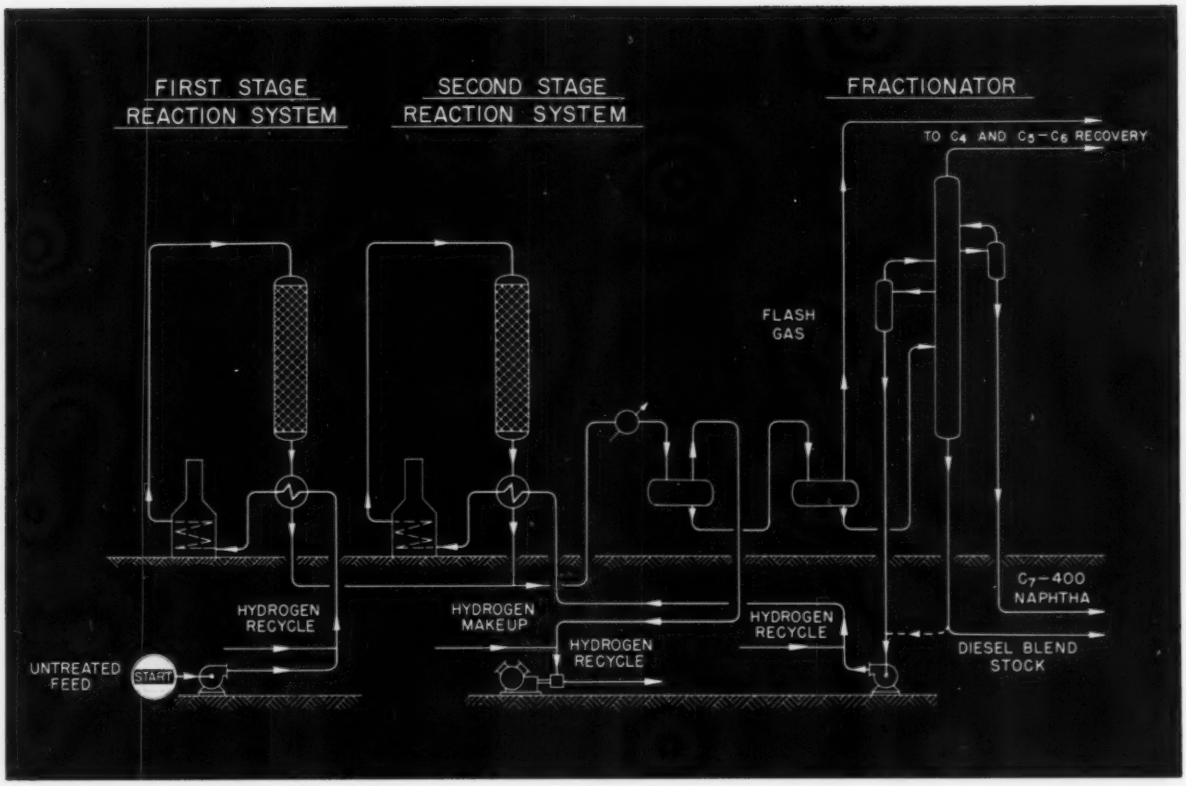
Description: Process employs fixed beds of catalyst and operates in an environment of hydrogen under pressure. The process flow diagram shown is for the processing of middle distillates to produce gasoline. The fresh feed undergoes partial conversion in its first pass through the reactor section. After gasoline and lighter components are separated from the reactor effluent by the stabilizer and fractionator, the unconverted distillate is returned by recycling to the reactor section for the completion of its conversion to gasoline.

In the case of processing vacuum gas oils, the fractionation system can be so arranged that both gasoline and middle distillate can be withdrawn as net products.

Yields: A tabulation of products and their properties is shown below for Lomax processing of a Wyoming-West Texas vacuum gas oil of 20.6 API gravity boiling between 590° and 920° F when maximizing middle distillates.

Reference: Sterba, M. J. and Watkins, C. H., "The Production of Gasoline From Distillates," presented before Western Petroleum Refiners Assn., San Antonio, March 28-30, 1960.

	Maximizing Middle Distillate			
Fraction	**180°-400° F**	**400°-525° F**	**400°-650° F**	**650° F +**
Volume Percent	22.6	23	47	39
Gravity, °API @ 60° F	47.8	39.5	37.5	37.5
Engler Distillation				
IBP, °F	240	405	425	670
10 Percent	280	420	468	710
50 Percent	320	441	530	764
90 Percent	359	480	610	865
E.P.	398	520	653	910
Hydrocarbon Types				
Paraffins	41	93.5	....	....
Naphthenes	51			
Olefins	1	0.9	....	....
Aromatics	7	5.6	....	....



Unicracking — UNION OIL COMPANY OF CALIFORNIA

Application: Production of quality gasoline stocks and premium midbarrel products by catalytic hydrocracking. Process converts all types of cracked and virgin distillates, including high-sulfur, high-nitrogen stocks, and produces no fuel oil.

Charge: Catalytic cycle oils; coker, virgin and thermal distillates; heavy catalytic naphthas.

Product: Unicracking is highly versatile; gas oils can be converted to gasoline stocks or to any desired proportion of gasoline stocks and high quality midbarrel stocks. Liquid product yield is generally from 110 to 120 volume percent of feed. Yield and quality of products from a typical high conversion operation follow:

Description: Unicracking is a fixed bed process that employs infrequent catalyst regeneration. Two stages of cracking are generally used as shown on the flow sheet. Untreated feed is introduced directly into the first stage where 30 to 50 percent of feed is converted to gasoline. The reactor effluents from both stages are brought together; and after appropriate cooling and liquid-gas separation, the liquid enters a common fractionator. The unconverted oil is the feed to the second reaction stage and is recycled to meet conversion requirements. Second stage conversion to gasoline is 50-70 percent per pass. Unconverted gas oil boiling range material is upgraded to high quality diesel.

Depending upon the feedstock and the objective, reactor temperatures range from 600° F to 800° F and operating pressures vary from 500 psig to 2,000 psig. Conventional refining equipment is used throughout.

Economics: See table and reference. Bases for these costs are: untreated high-aromatic feedstocks with 400°-600° F boiling range, four-product fractionation and initial catalyst charge included, hydrogen supply from catalytic reformer. The cost of hydrogen is not included.

Reference: PETROLEUM REFINER 39, No. 6, p. 169 (1960).

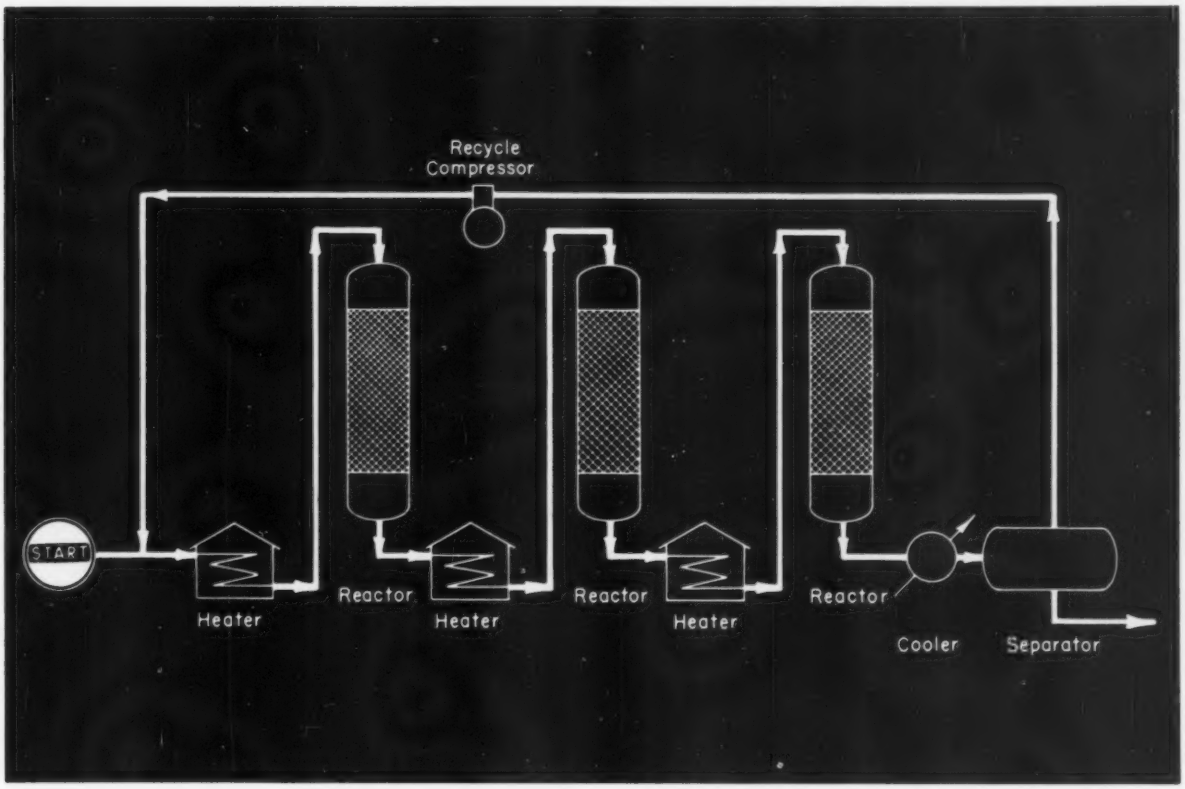
Unicracking West Texas Catalytic Cycle Oil

	Feed	PRODUCTS			
		C_4	C_5-C_6	C_7-400	Diesel Stock
Yield, volume percent of feed	100.0	12.9*	23.0	71.7	10.7
Gravity, °API	25.9	.....	82.0	43.7	40.6
ASTM Dist. Range, °F	446/577	.....	95/168	224/400	546/630
Sulfur, weight percent	1.17	.....	<0.003	<0.003	<0.01
Nitrogen, ppm	70	.....	.....	0.2	1.1
Hydrocarbon Analysis volume percent					
Paraffins	23	.....	80	25	.....
Naphthenes	12	.....	17	47	.....
Aromatics	53**	.....	3	28	.....
Octane Numbers					
F-1 + 3 ml TEL	.....	.....	98.5	90.0	.....
F-2 + 3 ml TEL	.....	.....	99.0	84.0	.....
Cetane Number	.....	.....	.....	.....	72

* 60 percent iC_4, 40 percent nC_4.
** Plus 7 percent olefins and 5 percent heterocyclics.

Unicracking Costs

Unit Charge, BPSD	5,000	15,000	15,000
Conversion, volume percent fresh feed	90	90	70
Capital Investment	$3,800,000	$8,400,000	$7,200,000
Direct Operating Costs, ¢/bbl. feed			
Operating Labor	3.9	1.9	1.9
Utilities	13.6	13.6	11.2
Catalyst	5.9	5.9	5.1
Maintenance	9.0	6.7	5.7
Total Direct	32.4	28.1	23.9



Reforming

PRESENT CAPACITY of catalytic reforming in the U.S. is about 1,940,000 barrels of charge per stream day, this capacity is equivalent to over 19 percent of our total crude running capacity.

Reforming continues to be the primary process for the production of motor fuel. This role, once held by catalytic cracking, has changed hands because of the continuing demand for higher octane blending components; a quality demand too high to be satisfied essentially by catalytically cracked stocks.

Reforming rearranges or reforms the components of naphtha into materials having higher octane ratings—primarily aromatics. When the reformed product is purified, it can find its way into petrochemicals. However, by far the greatest use of the reforming process is to produce motor fuel blending components.

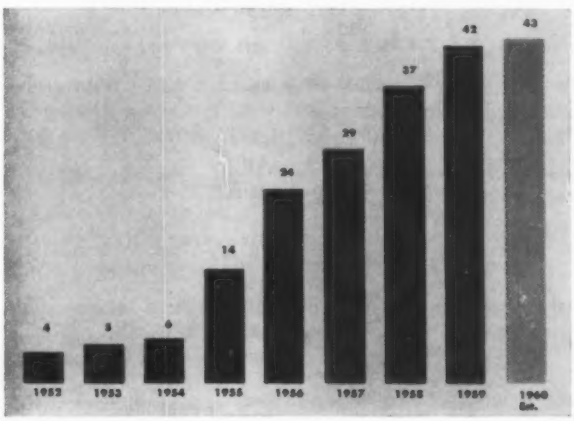
The tremendous growth of the reforming process can be shown by the accompanying bar graph. In this graph the catalytic reforming capacity at the beginning of each year is shown as a percentage of the average domestic gasoline demand for that year.

At the beginning of this year there was enough reforming capacity to furnish about 43 percent of our average domestic gasoline demand. This assumes the reformers are only on stream 90 percent of the time, but no deficit is taken for the decrease in product volume which occurs when operating for very high octanes.

The flow diagram of a typical fixed-bed catalytic reformer is shown above. The predominant reaction is the conversion of naphthenes into aromatics. If the reaction is carried out isothermally, the best relation of product yield to product octane is achieved. Since the reaction itself is endothermic, an outside source of heat is required to get the charge to process temperature and hold it there.

CATALYTIC REFORMING CAPACITY IN THE U.S.

(Percent of Average Domestic Gasoline Demand)



Compare Catalytic Reforming Processes

PROCESS	CATALYST				OPERATING CONDITIONS		First U.S. Unit On-stream
	Composition	Form	Bed Type	Regeneration	Temp. °F	Press., psig	
Cycloversion[1]	Bauxite	pellets	fixed	cyclic	950–1000	50–57	April 1940
Fixed-Bed Hydroforming	MoO_3/Al_2O_3	pellets	fixed	cyclic	1000	150	Nov. 1940
Platforming	Pt/Al_2O_3	pellets	fixed	none	900	750	Oct. 1949
Catforming	$Pt/SiO_2/Al_2O_3$	pellets	fixed	occasional	850–1000	300–700	Aug. 1952
Fluid Hydroforming	MoO_3/Al_2O_3	powder	fluid	separate	890–940	200	Dec. 1952
Houdriforming	Pt/...	pellets	fixed	occasional	950	300	Nov. 1953
Ultraforming	Pt/Al_2O_3	pellets	fixed	cyclic	900–950	200–500	May, 1954
Sinclair-Baker-Kellogg	Pt/Al_2O_3	pellets	fixed	cyclic	825–950	200–500	Sept. 1954
Sovaforming	Pt/...	pellets	fixed	occasional	.....	.....	Nov. 1954
Thermofor Catalytic	Cr_2O_3/Al_2O_3	beads	moving	separate	950–1000	100–200	Mar. 1955
Orthoforming	MoO_3/Al_2O_3	powder	fluid	separate	.....	.....	April 1955
Hyperforming	Cobalt Moly	pellets	moving	separate	870	400	May 1955
Powerforming	Pt/...	pellets	fixed	cyclic	.....	.....	July 1955
Rexforming	See Platforming	.....	.....	.....	.....	.....	April 1956
Iso-Plus	See Houdriforming	.....	.....	.....	.....	.....	April 1957

[1] First units used for desulfurization.

The dehydrogenation of the charge in reforming produces a hydrogen-rich stream. Some of the hydrogen is recycled to suppress coke formation, to sustain reactor pressure, and to furnish the requirements for any side reactions of hydrocracking which might occur. More hydrogen is produced, however, than is needed to fulfill the process requirements. Therefore, reforming is a ready source of hydrogen for other refining processes such as hydrodesulfurization.

For a comparison of the catalytic reforming processes which have been considered by the industry, examine the accompanying table. This table shows the type of catalysts, the operating conditions, and the time when the first unit was put on stream in the U.S.

Thermal reforming was the first method practiced for the upgrading of gasoline materials, being introduced shortly after 1930. The thermal process usually is accompanied with a production of gaseous materials so that polymerization is needed in order to give a good over-all yield of gasoline.

Catalytic reforming for gasoline upgrading was not put into operation until November 1940. The principle of catalytic reforming was practiced earlier, but it was of a milder nature for the desulfurization of a stock. The next reforming process was not introduced until early in 1949. Even by the end of 1951, reforming furnished only a little over 100,000 daily barrels, and most of this was spurred into existence by the demand for toluene during World War II.

The first announcements of catalytic reforming were followed by many more until now there are 15 processes devised for reforming naphthas and gasolines for octanes. Some of these applied the fluidized catalyst technique to their operation. Others combined aromatic separation and raffinate recycle to achieve higher aromatic production.

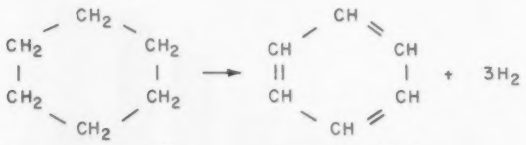
Some typical reactions are shown below to exemplify what happens during reforming. The numbers in parentheses are the octanes of the compounds at 3 cc TEL per gallon.

The dehydrogenation of naphthenes is the predominant reaction. The isomerization of naphthenes and paraffines is next followed by dehydrocyclization and hydrocracking.

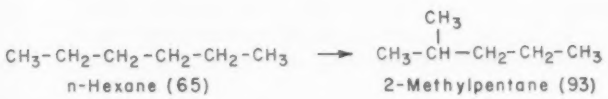
A review of catalytic reforming is included in the comprehensive article by Marshall Sittig on "How to Get Those Top Octanes," PETROLEUM REFINER 34, No. 9, 230-280 (1955).

These Reactions Occur During Reforming

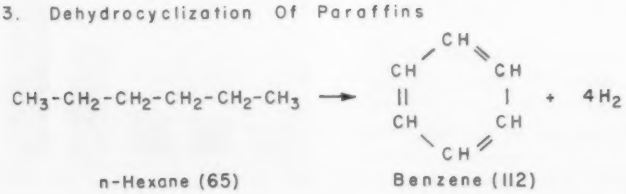
1. Dehydrogenation Of Naphthenes



2. Isomerization Of Paraffins



3. Dehydrocyclization Of Paraffins



Catalytic Reforming — THE M. W. KELLOGG COMPANY

Application: For reforming low-grade naphthas to aromatic, high-octane gasoline using a fixed-bed platinum containing catalyst.

Charge: Light, heavy and full-boiling range virgin naphthas, including those from high-sulfur crudes. Thermally and catalytically cracked naphthas are also reformed successfully after preliminary treatment by Kellogg hydrogen desulfurizing.

Product: Premium or aviation gasoline ranging from 85 to more than 100 F-1 clear octane number, depending upon requirements. The reformate is a rich source of pure aromatics. The process also produces significant amounts of isobutane for alkylation and hydrogen for upgrading other refinery streams.

Description: A typical reformer designed to produce 95 to 100 F-1 clear octane reformate would consist of three principal parts; a pretreat or catalytic desulfurization section, the reforming section proper, and the reforming catalyst regeneration equipment. Feed naphtha is charged through an absorber to the high pressure desulfurizer, along with hydrogen-rich gas produced in the unit, for removal of harmful metallic, nitrogen, and arsenic compounds, desulfurization, and saturation of olefinic compounds. The desulfurizer effluent passes through a stripper, is joined by hydrogen-rich recycle gas, and receives preheat to reforming temperature prior to entering the first reforming reactor.

The reforming section can contain up to five reactors, the first three in series flow, and the last two in parallel. Three reheat furnaces are interposed between the reaction steps. The effluent from the final reactor is passed through reboilers and coolers to the high pressure separator where the total reactor effluent is separated into liquid and gas fractions. The gas, high in hydrogen content, is compressed and recycled to the inlet naphtha feed system. The liquid fraction is fed to a column for stabilization to produce the debutanized reformate product. Hydrogen is produced in excess of process requirements and may be utilized in other processes.

Operating cycles are a function of feed characteristics and octane severity. However, they are comparatively long. Catalyst is regenerated in place. Any of the three terminal reactors may be shut down for regeneration with no marked disturbance to the operation. When a reactor is being regenerated the remaining four are operated in series; the first two reactors need be regenerated only when the unit is shut down for turnaround.

Operating Conditions: The preferred range of reactor conditions is 200-500 psig and 875°-975° F, with a recycle gas rate of 5,000-8,000 scf/bbl feed.

Yields: The following data give typical yields for reforming Mid-Continent and Kuwait virgin naphthas in the 200°-400° F boiling range:

Feedstock	Mid-Continent		Kuwait	
Gravity, °API	54.6		57.2	
Paraffins, Vol %	51.0		59.7	
Naphthenes, Vol %	38.3		24.6	
Aromatics, Vol %	10.7		15.7	
Reformate				
F-1 clear octane	95	100	95	100
Yield C_5+ reformate, Vol %	81.4	76.9	78.2	73.2
Yield C_4's, Vol %	6.2	7.8	7.2	8.8
Yield dry gas, Wt %	9.8	12.3	10.4	12.8

Economics: Installation costs are $125-350 per barrel for capacities from 3,000 to 30,000 bpsd. Typical operating costs for a 10,000 bpsd unit are given below.

Feedstock Source	Kuwait		Mid-Continent	
Product octane-F-1 clear C_5+	90	95	90	95
Direct operating cost, ¢/bbl feed	16.6	21.3	13.8	16.5
Total operating cost, ¢/bbl feed	28.8	35.4	25.7	29.3

Commercial Installations: Seventeen units designed by Kellogg are operating or under construction having a total charge capacity of 133,675 bpsd.

Reference: PETROLEUM REFINER 34, No. 9, 190 (1955).

Catforming — THE ATLANTIC REFINING COMPANY

Application: To convert low-octane naphthas to finished high-octane gasoline and to produce aromatics for petrochemicals or aviation gasoline. The distinctive yield distribution obtained by use of the reforming catalyst warrants its use where either maximum byproduct LPG or isobutane is desired. An additional benefit is the relatively high purity of the byproduct hydrogen produced.

Charge: A range of different feed stocks: Light naphtha, full boiling range and so-called typical heavy naphtha reformer feeds. The distinctive selectivity of the catalyst becomes most apparent on the higher boiling and more paraffinic naphthas. In addition to straight run naphthas of wide or close cut boiling range, hydrogenated cracked naphthas or selected cuts for aromatics production may also be charged.

Product: For motor gasoline operation, the reactor product requires only stabilization before inclusion in finished gasoline. No rerunning, sweetening or other finishing treatment is required.

Description: Atlantic Catforming is a selective catalytic reforming process employing a platinum-silica-alumina catalyst. Naphtha may be charged to the reaction section without feed preparation; however, for high-severity operations hydrogen pre-treating is recommended. The feed is joined with a hydrogen-rich recycle gas stream and preheated by exchange with effluent from the last reactor. The mixture is then heated to reaction temperature in a furnace and passed through fixed-bed reactors in series. Reheaters between the reactors are used to compensate for the heat consumed in aromatics formation. The effluent from the final reactor, after exchange with the feed, is condensed in a cooler and separated from the hydrogen recycle and make gas in a high-pressure flash. The recycle hydrogen is compressed and returned to the reactors, while net hydrogen production is vented from the unit under pressure control. Having a high hydrogen content, the make gas may be used in hydrogenation or in petrochemical processing. Liquid from the flash drum flows to a conventional stabilizer.

In Catforming high-sulfur stocks at low or moderate severity, desulfurization may be accomplished by conventional scrubbing of the recycle gas in an amine absorber. As noted before, high-severity operations make desulfurization by hydrogen pre-heating an economic method.

Carbon is deposited very gradually on the catalyst during normal operation. After a long run, the catalyst may be restored in activity by burning the carbon deposit in a combustion stream of low oxygen content. The ability to regenerate simply and quickly in place also saves considerable catalyst life if a major upset lays down a heavy carbon deposit. Catalyst life extends through several use-regeneration cycles before change of catalyst is required.

Operating Conditions: Reaction temperature varies from 850° F to 1,000° F while pressure is maintained at 300-700 psig. Product yields and qualities depend heavily on feed properties and operating severity.

Yields: Either of two distinctive type catalysts can be used as best suits the yield distribution required. Typical yields and qualities for two feed stocks using one of these catalysts are shown in the accompanying table.

Economics: Unit design economics vary with required reforming severity and unit size, but experience has demonstrated a minimum investment and operating expense requirement with Catformer design simplicity.

Commercial Installation: There are units in operation in many different countries. Unit capacities range from 500 to 15,000 bpd.

Reference: PETROLEUM REFINER 36, No. 4, 146 (1957).

Feed Source	Middle East		Mid-Continent	
Nominal Boiling Range, °F	200–400°		200–400°	
Charge Properties				
Gravity, °API	57.1		53.8	
F-1 Octane-clear	36.5		42.2	
RVP, psi	0.5		0.5	
Composition, Vol. %				
Paraffin	63.4		45.6	
Napththene	23.7		46.7	
Aromatic	12.4		7.7	
ASTM Dist., °F				
10%	240		247	
50%	281		288	
90%	330		337	
Yield Structure				
C_5+ Reformate				
F-1 clear	90.0	95.0	90.0	95.0
F-1 3cc	98.5	101.0	98.0	100.5
Vol. %	77.6	71.6	81.6	76.0
RVP, psi	4.8	5.6	4.4	5.1
Light H-C Yield, % on Feed				
Normal Butane—Volume	7.3	8.7	5.4	6.9
Isobutane—Volume	6.8	8.2	5.1	6.4
Propane—Weight	6.0	7.8	4.1	5.9
Ethane—Weight	2.1	3.2	1.0	1.9
Methane—Weight	1.2	1.9	0.7	1.2
Hydrogen—Weight	0.8	0.9	1.3	1.4

Cycloversion — PHILLIPS PETROLEUM COMPANY

Application: Used (1) to desulfurize straight run and cracked gasolines, naphtha fractions and kerosines, (2) to reform straight run gasoline or naphtha in order to upgrade octane numbers and to improve lead susceptibility, (3) to catalytically crack gas oil stocks for the production of high octane gasoline. Desulfurization is particularly applicable in preparation of feed stocks for catalytic reforming operations.

Charge: Under desulfurization conditions the charge stocks can be either a full boiling range gasoline or a naphtha fraction. Various mixtures of cracked and straight run charge stocks can be processed in a combined operation. Under reforming conditions the charge stocks are similar to those processed to effect desulfurization. Gas oil cracking charge stocks having a boiling range 400°-800°F. can be satisfactorily processed.

Product: Catalytic desulfurization of the straight run or natural gasoline charge stocks results in no appreciable change in the composition of the treated product other than the reduction of sulfur content. With cracked gasoline the octane improvement is due to desulfurization and some isomerization. The absence of undesirable side reactions is indicated by the fact that there is no appreciable change in physical properties such as vapor pressure, gravity or distillation characteristics.

Benefits gained by catalytic reforming include those obtained from catalytic desulfurization together with an appreciable increase in clear and leaded octane ratings.

Catalytic gas oil cracking yields highly olefinic gases, high octane motor fuel, low pour point recycle stocks and bottoms.

Description: Cycloversion is a fixed-bed catalytic reforming process. The heater and heat exchangers are of conventional design and serve to heat the feed stock to the desired temperature with a minimum of thermal decomposition. Two reactors are provided for continuous operation, i.e., one chamber is on process while the other is being regenerated. The rerun and stabilization facilities are also conventional in design. The steam superheater and air compressor are regeneration facilities which are used for reactivating the catalyst in situ. An installation of this type can be used for any of the applications of Cycloversion. However, rerun and stabilization facilities are not required for straight run desulfurization. Also, some units built for desulfurization service, have only a single reactor and no not include regeneration facilities. These installations discard the catalyst when it is spent and recharge the reactor with new catalyst.

The higher carbon deposition on the catalyst for gas oil cracking and reforming operations precludes the use of the non-regenerative unit. Process cycles vary from 3 to 12 hours when processing gas oil and from 12 to 72 when reforming. Steam is added with the gas oil charge to suppress carbon deposition on the catalyst but is not generally used in the desulfurization or reforming operation.

Caustic washing facilities are generally provided to remove the H_2S formed when the sulfur compounds are decomposed. No further treatment is usually necessary.

The catalyst is cyclocel grade bauxite and is a natural occurring material. It has a life of 5000,-20,000 barrels per ton when used in non-regenerative desulfurization units and 50,000-100,000 barrels per ton when used in regenerative units.

Operating Condition: The major process variables are temperature, pressure, and space velocity. High temperatures increase the depth of conversion. Lower pressures increase the olefinicity of the gasoline obtained from gas oil cracking which in turn increases the octane rating of the product. Increasing space velocity at constant temperature and pressure decreases the depth of conversion.

Yields: In the desulfurization operations, the yields are 98.0-99.5 liquid volume percent of charge. Yields from reforming are dependent on the severity of the operation. This is also true for gas oil cracking though in this operation a 50 percent conversion is considered normal. Typical data for the three types of operation which can be performed in the Cycloversion process are shown in the tables below.

TABLE 1

Cycloversion of Mid-Continent Gas Oil

Feed Stock:		
Gravity, °API	32.2	....
10 Percent (Vacuum)	604	....
90 Percent (Vacuum)	752	....
Aniline Point, °F	181	....
Catalytic Gasoline, C_5—400° F	Test 1	Test 2
Gravity, API°	55.1	54.9
Reid Vapor Pressure	6.0	6.6
F-2 Octane Number	80.4	81.1
+3 cc. TEL	84.5	84.7
F-1 Octane Number	94.3	94.5
+3 cc. TEL	97.8	98.0
Yields, Percent of Charge:		
Cat. Gasoline, C_5-400° F., Vol. Percent	28.6	33.2
10 Lb. RVP., Gasoline, Vol. Percent	37.4	42.9
Propylene, Vol. Percent	4.1	4.2
Butylenes, Vol. Percent	4.9	5.6
Cat. Recycle 400° F., + Vol. Percent	59.1	50.7
Carbon, Weight Percent	1.5	2.3
Conversion, Single Pass Vol. Percent	40.9	49.3

* Butanized and includes potential catalytic poly gasoline.

TABLE 2—Reforming

Sample Designation		Debutanized Reformed Naphtha	
Test Number	Charge	One	Two
Operating Conditions:			
Space Velocity, V/V/Hr.	....	1.0	1.0
Cat. Chamber Inlet, °F	....	875	974
Cat. Chamber Pres., Psig	....	50	50
Yield Summary:			
Debut. Ref. Naph., Vol. Percent Charge	....	95.6	88.7
F-1 Octane Ratings:			
Clear	42.7	52.2	68.0
Plus 1.0 cc. TEL/Gal	51.0	62.3	75.4
Plus 3.0 cc. TEL/Gal	59.4	73.3	83.3
API Gravity @ 60 F	46.9	46.3	46.1
R.V.P. psi	1.5	1.1	3.2
Total Sulfur, Weight Percent	0.184	0.011	0.020
ASTM Dist. °F:			
IBP	271	187	129
10 Percent	312	297	259
30 Percent	324	320	309
50 Percent	334	333	327
70 Percent	346	348	344
90 Percent	365	370	367
End Point	416	429	442

TABLE 3—Desulfurization

	Straight-Run Gasoline	
	Charge	Product
Operating Conditions:		
Space Velocity, V/V/Hr.	....	1.0
Cat. Chamber Inlet, °F	....	803
Cat. Chamber Pres., Psig	....	50
F-1 Octane Range:		
Clear	64.2	66.3
Plus 1.0 cc. TEL/Gal.	71.5	76.6
Plus 3.0 cc. TEL/Gal.	78.1	85.5
Yield Summary:		
Yield, Vol. Percent Charge	....	99.6
API Gravity @ 60° F.	64.6	63.9
R.V.P. psi	11.1	10.7
Total Sulfur, Weight Percent	0.123	0.004
Mercaptan Sulfur, Weight Percent	0.049	0.001
Doctor Test	Sour	Sweet
ASTM Dist. °F:		
IBP	94	96
10 Percent	117	131
30 Percent	171	176
50 Percent	207	203
70 Percent	239	239
90 Percent	281	278
End Point	339	343

Houdriforming — HOUDRY PROCESS CORPORATION

Application: To reform straight run and cracked naphthas using a platinum-containing catalyst.

Charge: A wide variety of feedstocks, differing substantially in chemical composition and having end boiling points up to 400° F. Low-octane naphthas may be upgraded efficiently to obtain very high octane level components required for blending in present-day motor fuels.

Products: Aviation blending stocks, aromatics, and motor gasoline in the 80-100 F-1 clear octane range, depending upon feed composition and type or severity of operating conditions. Stabilized Houdriformate requires no further treatment.

Description: Houdriforming catalyst used in the process meets exacting specifications for activity, selectivity and strength. It is well balanced to carry out the dehydrogenation, aromatization, isomerization, hydrocracking and desulfurization reactions involved.

Pre-treatment of high-sulfur stocks is provided by means of a catalytic pretreat chamber with its own preheater. This "guard case" is constructed as an integral stage of the Houdriforming operation when required for the feed stock.

At moderate severities, Houdriforming may be operated continuously for either high octane motor gasoline or aromatics, without provision for catalyst regeneration. The process also provides refineries with hydrogen of high purity for use in other refinery processes.

If high severity operation is required, Houdriforming lends itself readily to in-place catalyst regeneration, as has been demonstrated commercially.

When operated for aromatics, Houdriforming converts the appropriate naphthenes to benzene, toluene and xylenes at yields approaching 100 percent of theoretical values, with significant aromatization of paraffins.

Commercial Installations: Total licensed Houdriforming capacity amounts to 194,240 bpsd. Worldwide, 24 units are now on stream or under construction ranging in size from 500 to 45,000 bpsd design capacity. In addition to licensed Houdriformer units, 18,000 bpsd of other catalytic reforming capacity utilizes Houdriforming catalyst.

Operating Conditions: Temperature 875°-980° F; pressures 250-600 psig; space velocity, 1.5-5.0 v/hr/v; hydrogen-oil mole ratio 4-10.

HOUDRIFORMING FOR MOTOR GASOLINE

Debutanized Reformate, Volume Percent	F-1 Octane With 3cc TEL
94.4	93.9
91.9	96.9
90.3	98.3
87.5	100.0

Reformate Inspection	Naphtha Charge	Reformate
Gravity, °API	52.6	47.7
Distillation, °F. Ibp	198	114
10	222	188
30	242	228
50	264	256
90	340	340
D.P.	376	406
F-1 Octane Clear	54.6	89.5
F-1 Octane + 3cc TEL	76.2	98.5
Composition (Depentanized Bases)		
Paraffins	42.7	39.1
Olefins	0.7	1.1
Napththenes	37.8	3.4
Aromatics	18.8	56.4

HOUDRIFORMING FOR AROMATICS

Type of Operation	Benzene-Toluene	Xylene
Charge Composition, Volume Percent		
Paraffin	49	52
Naphthenes	44	40
Aromatics	7	8
Plant Charge Rate, BPD	12,500	10,000
Plant Yields		
Stabilized Product, Volume Percent	90.8	87.0
High Pressure Gas, SCF/Bbl	1120	1140
Product Composition, Volume Percent		
Paraffin	53	52
Olefins	0	0
Naphthenes	4	0
Aromatics	43	48
Hydrogen Purity of High Pressure Gas	97	95.5
Plant Performance		
Net Aromatics Yield, Vol. Percent of Charge	32.0	33.8
Net Aromatics, Percent of Theoretical	87	101

Note: These yields were established by surveys of plant performance after five months catalyst life.

Reference: PETROLEUM REFINER 32, No. 5, 113 (1953).

Platforming — UNIVERSAL OIL PRODUCTS COMPANY

Application: (1) To upgrade low-octane naphthas to premium quality motor fuels, (2) to produce high yields of aromatic hydrocarbons from select naphtha cuts, and (3) to produce high-quality aviation gasoline components.

Charge: For motor fuel operation; straight-run and/or cracked naphthas boiling in the range of 150°-400° F. For aromatics or avgas operation; selected straight-run naphtha fractions.

Products: Motor fuel operation: Typical product is stable, requires no rerunning, and can be produced at any desired quality to fit marketing requirements.

Aromatics operation: Product contains benzene, toluene, xylenes, and other aromatics. The charge stock, boiling range and unit operating conditions are adjusted to maximize production of the desired individual aromatics. Separation of aromatics from the Platformate is accomplished by Udex solvent extraction, followed by the recovery of individual aromatics in extremely high purity by distillation.

Description: A typical Platforming unit may be divided into three parts: the reactor-heater section in which the charge plus recycle gas is heated and passed over the catalyst; the separation and compression in which the reactor effluent is separated into gas and liquid streams, the gas being compressed for recycling; and the stabilization section in which the separator liquid is stabilized to the desired vapor pressure.

Depending upon the character of the feed stock, it may be desirable to add a recycle gas scrubbing system to remove H_2S from the gas. The Unifining process has proved valuable as a means of producing satisfactory feed stocks from otherwise unsuitable materials.

The principal chemical reactions involved are dehydrogenation of naphthenes to aromatics, dehydrocyclization of paraffins, hydrocracking of high molecular-weight paraffins to lower molecular-weight paraffins, isomerization of paraffins and of naphthenes, and desulfurization of sulfur compounds, forming hydrogen sulfide.

Operating Conditions: The four major process variables are temperature, space velocity, pressure and hydrogen recycle rate. The reactor temperature is normally in the range of 850°-980° F when operating at pressures from 200-800 psig.

Yields: Platformates produced from a Mid-Continent naphtha under three different operating conditions are shown in the table.

Commercial Installations: Platforming is the pioneer catalytic reforming process employing a platinum-containing catalyst. Units from 150 to 29,000 barrels per stream day are in commercial operation.

Reference: PETROLEUM REFINER 31, No. 5, 97 (1952).

	Charge Stock	PLATFORMATES		
		1	2	3
Yield of 10 lb. RVP Plat., L.V. Percent of Charge	.....	101.0	96.8	89.3
Extraneous C_4 Req. to 10 lb. RVP, L.V. Percent of Charge	.....	8.2	6.2	1.8
RVP, psi	0.2	10.0	10.0	10.0
Octane Ratings:				
Research Clear	32.4	85.0	90.0	95.0
+ 3ml. TEL/Gallon	56.4	95.5	98.5	iso +0.12
Percent Sulfur	0.04	....	....	....
Molecular Weight	128	....	....	....
UOP "K"	11.93	....	....	....
Debutanized Gasoline:				
°API	52.6	48.0	46.8	44.8
100 Ml. Dist. °F:				
IBP	230	144	140	132
10 Percent	255	200	191	173
50 Percent	**308**	**285**	**281**	**272**
90 Percent	372	366	366	365
95 Percent	382	384	386	389
End Point	397	410	412	413

Powerforming—ESSO RESEARCH AND ENGINEERING COMPANY

Application: Produces Powerformates of 85-100+ Research Octane Number clear from low-octane naphthas. Alternatively, the process may be operated to produce aviation blending stocks or to give high yields of aromatics. Powerforming also produces large quantities of hydrogen.

Charge: Typically low-octane naphthas in the boiling range from 160° to 400° F.

Products: Typical yields and product quality information for 100 Research Octane Number clear Powerformates are shown in Table 1. Powerformers also produce large volumes of by-product hydrogen which may be used to desulfurize the feed and to improve the quality of other refinery products.

TABLE 1—Powerformer Feeds and Products

CRUDE	Arabian	Arabian	Louisiana	West Texas
FEED STOCK				
Gravity, °API	61.6	49.6	55.0	53.0
F-1 O.N., clear	42	26	58	56
ASTM Distillation, °F				
5 Percent	190	310	223	235
50 Percent	236	342	253	260
95 Percent	294	380	304	291
YIELDS				
C_5 plus, vol. percent	64.3	78.3	77.5	81.0
H_2, weight percent	1.3	1.3	2.1	2.0
C_1-C_3, weight percent	18.2	9.8	9.7	8.4
C_4, volume percent	15.0	8.4	8.8	7.8
PRODUCT QUALITY (C_5 plus)				
RVP, psi	6.7	4.2	4.0	3.1
F-1 O.N., clear	100.0	100.0	100.0	100.0
F-1 O.N. + 3cc TEL	104.3	103.5	103.9	103.9
F-2 O.N., clear	89.9	89.9	89.6	89.5
F-2 O.N. + 3cc TEL	95.5	94.4	94.8	94.6

Description: Powerforming is a fixed-bed catalytic reforming process employing a new platinum catalyst. The naphtha feed to a Powerformer is desulfurized in a Hydrofining unit. After stripping to remove hydrogen sulfide, the feed is combined with hydrogen-rich recycle gas from the Powerformer separator drum. This mixture then flows in series through 3 or 4 reactors each of which is preceded by a fired heater. The effluent from the last reactor is cooled and pases to the separator drum. The Powerformate from the separator drum is stabilized in conventional equipment. Part of the gas from the separator drum is recycled to the first reactor. The net hydrogen produced is used to desulfurize the feed and to treat other refinery products.

The Powerforming catalyst is regenerated periodically to restore its activity and selectivity. For processing average feed stocks to Research Octane Numbers clear of 98 or less, a semi-regenerative design is employed. In this type of Powerformer, the unit is taken off stream at intervals of 2 to 6 months while all of the reactors are regenerated.

For processing poor quality feedstocks to 100 Research Octane Number clear or higher, a cyclic regeneration system is used. In a cyclic Powerformer, reactors are regenerated individually without taking the unit off stream and an additional "swing" reactor is provided which replaces each on-oil reactor as its catalyst is being regenerated. The rugged supported platinum catalyst maintains its activity and selectivity for years despite frequent regenerations.

Commercial Installations: The first commercial Powerformers were put in operation during the summer of 1955. Capacities of Powerforming units currently in operation, under construction, or planned are shown in Table 2.

Reference: PETROLEUM REFINER 36, No. 9, 221 (1957).

TABLE 2—Powerforming Installations

Company	Location	Capacity B/SD	Unit Type†	Start-Up
Humble Oil & Ref. Co.	Baytown, Texas	20,000	Cyc.	1955
Humble Oil & Ref. Co.	Baytown, Texas	20,000	Cyc.	1955
Esso Standard Oil Co.	Baltimore, Md.	Shut Down	SR	1955
Imperial Oil Ltd.	Edmonton, Alta.	2,000	SR	1955
Carter Oil Co.	Billings, Mont.	2,500	SR	1956
Raffineria Garrone*	Genoa, Italy	5,600	Cyc.	1957
Imperial Oil Ltd.	Sarnia, Ont.	15,000	SR	1957
Imperial Oil Ltd.	Montreal, Que.	9,000	Cyc.	1957
Imperial Oil Ltd.	Halifax, N.S.	7,000	Cyc.	1957
Rasiom*	Augusta, Sicily	7,300	Cyc.	1957
Stanic	Bari, Itay	7,300	Cyc.	1957
Esso Standard Italiana	Trieste, Italy	1,000	SR	1957
Esso Standard Oil Co.	Linden, N.J.	20,000	Cyc.	1957
Esso Standard Oil Co.	Everett, Mass.	7,200	SR	1957
Esso Standard Oil, S.A.	Belot, Cuba	2,650	SR	1958
Imperial Oil Ltd.	Ioco, Brit. Col.	5,500	Cyc.	1958
International Refineries, Inc*	Wrenshall, Minn.	2,800	SR	1958
Imperial Oil Ltd.	Winnipeg, Manitoba	3,000	Cyc.	1958
Esso Belgium, S.A.	Antwerp, Belgium	5,600	Cyc.	1958
Esso Standard Oil Co.	Baton Rouge, La.	26,900	Cyc.	1958
Standard Vacuum Oil Co.	Durban, S. Africa	5,630	SR	1958
Cie. Francaise de Raffinage*	La Mede, France	20,000	Cyc.	1958
Esso A.G.	Koln, Germany	9,000	Cyc.	1959
Esso Std. S.A.F.	Port Jerome, France	14,500	Cyc.	1959
Esso Std. S.A.F.	Bordeaux, France	8,030	Cyc.	1959
Esso Petroleum Co., Ltd.	Fawley, England	21,000	Cyc.	1959
Irish Refining Co., Ltd.*	Whitegate, Eire	9,000	Cyc.	1959
Standard Vacuum Oil Co.	Shimizu, Japan	4,830	Cyc.	(1959)
Govt. Oil Ref. Admin.	Baghdad, Iraq	5,000	Cyc.	(1959)
Imperial Oil Ltd.	Regina, Sask.	3,000	Cyc.	(1959)
Esso Nederland N.V.	Rotterdam, Neth.	16,500	Cyc.	(1960)
Esso Petroleum Co., Ltd.	Milford Haven, Wales	16,500	SR	(1960)
A/S Esso-Raffineriet	Slagen, Norway	7,200	SR	(1960)
Raffineria Garrone*	Genoa, Italy	8,800	Cyc.	(1961)

* Licensee
† SR: Semi-Regenerative. Cyc: Cyclic Regeneration.

Ultraforming — STANDARD OIL COMPANY (INDIANA)

Application: To convert low-octane naphthas to high-octane blending stocks. Ultraforming is especially designed to produce gasoline blending stocks with clear-octane ratings up to 102-104* without the use of auxiliary processes.

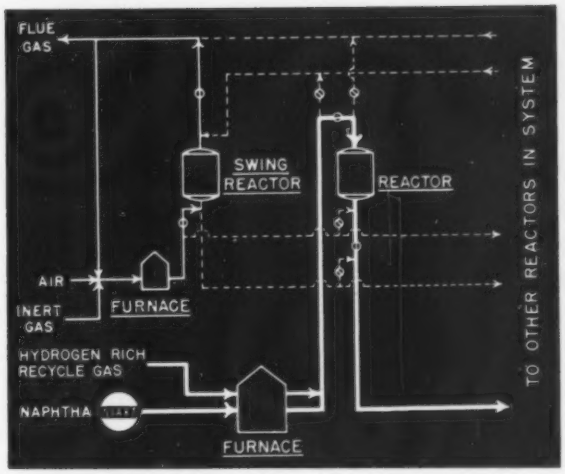
Charge: Either straightrun or mixtures of straightrun and cracked naphthas. Because the process has regeneration facilities, boiling range of the charge is not critical. Selected fractions of straightrun naphtha may be processed for avgas or aromatics operations.

Product: Typical commercial operations give reformates of 95-102 F-1 octane number, clear. Total Ultraformate may be split into a light and heavy fractionation by distillation to obtain a C_7+ blending stock having a clear-octane rating of 108-110.

Description: Ultraforming is a regenerative, fixed-bed catalytic reforming process employing several distinctive process features. Frequent on-stream catalyst regeneration is made possible by a unique process design which includes a swing reactor. When catalyst activity in an on-stream reactor declines, that reactor is temporarily replaced by the swing reactor. Reforming operations continue while catalyst in the isolated reactor is regenerated in situ with air and inert gas. After regeneration, the freshly regenerated reactor is placed back on stream and the swing reactor is again available to replace any other reactor in the system. The valve and piping arrangement used to switch reactors is shown in the accompanying flow diagram.

Other distinctive Ultraforming features are low reaction pressures, low gas recycle rates and a special catalyst regeneration technique. The combination of Ultraforming's swing-reactor design, catalyst regeneration technique and operating conditions result in maximum octane potential, higher gasoline and hydrogen yields and greater process flexibility.

Ultraforming catalyst, has been successfully regenerated up to 300 times in commercial units. Several commercial installations have now attained catalyst lives between 100-200 barrels per pound and catalyst activity in these units is still being maintained at initial activity.



How valves are used to switch reactor service

Operating Conditions: Usually a reactor pressure of about 200-300 psi and a reactor-inlet temperature of 900-950° F. Hydrogen recycle rate and space velocity are adjusted to the particular characteristics of the charge and to the product desired.

Yields: Ultraforming yields from severe reforming of Gulf Coast, Mid-Continent and Kuwait naphthas are shown in the accompanying table.

Commercial Installations: A total of 25 commercial Ultraforming units of Standard, its affiliates and licensees, are operating.

Reference: PETROLEUM REFINER 35, No. 5, p 171 (1956).

* For octane numbers over 100, the Wiese extension of the octane scale is used.

ULTRAFORMING YIELDS

	Gulf Coast		Mid-Continent		Kuwait	
Charge Naphtha						
ASTM Dist., °F.						
Initial	238		200		193	
10 percent	263		230		220	
50 percent	304		262		266	
90 percent	357		316		330	
End Point	400		362		366	
Composition, Volume Percent						
Paraffins	35		51.3		68.5	
Naphthenes	51		36.2		20.5	
Aromatics	14		12.5		11.0	
Research Octane No., Clear	42.8		48.4		35	
Products						
C_5 + Reformate						
Research Octane No., Clear	100	103.5	98	102	95	100
Yield, Volume percent	80.9	75.5	79.4	74.4	75.0	63.8
RVP, psi	2.9	3.5	3.4	3.4	5.1	5.9
Butanes, Volume percent	5.1	7.1	6.6	8.8	10.8	15.4
Dry Gas, Weight percent	8.8	12.2	10.1	12.9	12.7	19.8
Hydrogen scf/bbl	1330	1330	1100	1150	710	750
10-psi Gasoline						
Research Octane No., Clear	100	103.5	98	102	95	100
Yield, Volume Percent	89.7	81.0	88.1	81.5	80.5	67.4

Iso-Plus Houdriforming—HOUDRY PROCESS CORPORATION

Application: Combines conventional catalytic Houdriforming with either thermal reforming or aromatics separation to convert low-octane naphthas into high-octane gasolines.

Charge: A wide variey of feed stocks, differing substantially in chemical composition and having final boiling points up to 400° F.

Product: Gasoline in the range of 100 and higher F-1 clear octane numbers.

Description: Flow diagrams are presented for each of the three Iso-Plus routes.

In each of the three Iso-Plus routes, virgin naphtha feed is first charged to a Houdriformer pretreat (guard case) section consisting of heater and catalytic reaction chamber, and thence to a stripper tower venting H_2S and other contaminants to fuel. Effluent moves to the Houdriformer's three heaters and catalytic reactors in series. Operating conditions for Houdriforming are mild in all three Iso-Plus variations.

Iso-Plus with thermal reforming yields an 87 F-1 clear Houdriformate. This is depropanized and dependanized, with propanes going to refinery fuel, and butanes and pentanes taken for final blending. The dependanized effluent undergoes thermal reforming, and is flashed and debutanized. The thermal C_3-C_4 olefins are polymerized catalytically and this product gasoline goes to blending with the reformate, butanes and pentanes.

In one of the Iso-Plus designs employing aromatics separation, the 87 F-1 clear Houdriformate is flashed, depropanized, dependanized; butanes and pentanes go to product. Dependanized effluent is charged to aromatics extraction, with a 91 percent aromatics concentrate separated as product. An 81 percent paraffinic raffinate moves to a second Houdriforming stage, yielding 81 F-1 clear Houdriformate for flashing and depropanizing. The final blend of 100 octane F-1 clear gasoline consists of the aromatic concentrate, butanes and pentanes from the first Houdriforming stage, and depropanized Houdriformate from the second Houdriformer. As a variation to this alternative, second-pass Houdriformate may be recycled to aromatics extraction, making it possible to recover more than 80 percent of naphtha feed as 108 F-1 clear octane 10 lb. RVP gasoline.

The second Iso-Plus aromatics separation design eliminates the second Houdriforming stage, and provides for depropanizing, debutanizing and dependanizing an 83 F-1 clear Houdriformate. Most of the butanes and part of the debutanized reformate go to final product. Dependanized Houdriformate undergoes aromatics extraction; concentrate goes to product and paraffinic raffinate recycle to the Houdriforming section.

Yields: Experimental runs of Iso-Plus aromatics extraction variations have achieved yields of 100 octane F-1 clear gasoline of up to 91 percent of naphtha feed. One of these variations, with slight operational modification, yields 82 percent of charge as 108 F-1 clear gasoline. Iso-Plus Houdriforming using supplemental thermal reforming yields 80 to 90 percent of reformed gasoline, depending upon desired octane value of final product.

Commercial Installations: Iso-Plus Houdriforming is in commercial operation in two variations. Houdriforming coupled with thermal reforming is being used in a 4,000-bpsd unit in Italy which charges naphtha from Middle East crudes. This unit has produced reformate having F-1 clear octane ratings as high as 104.

Houdriforming coupled with aromatics extractions and recycle of raffinate is being used in a large domestitc unit which processes naphthas principally from Middle East crudes. F-1 clear octane product above 100 is produced.

Reference: PETROLEUM REFINER 34, No. 9, 135 (1955).

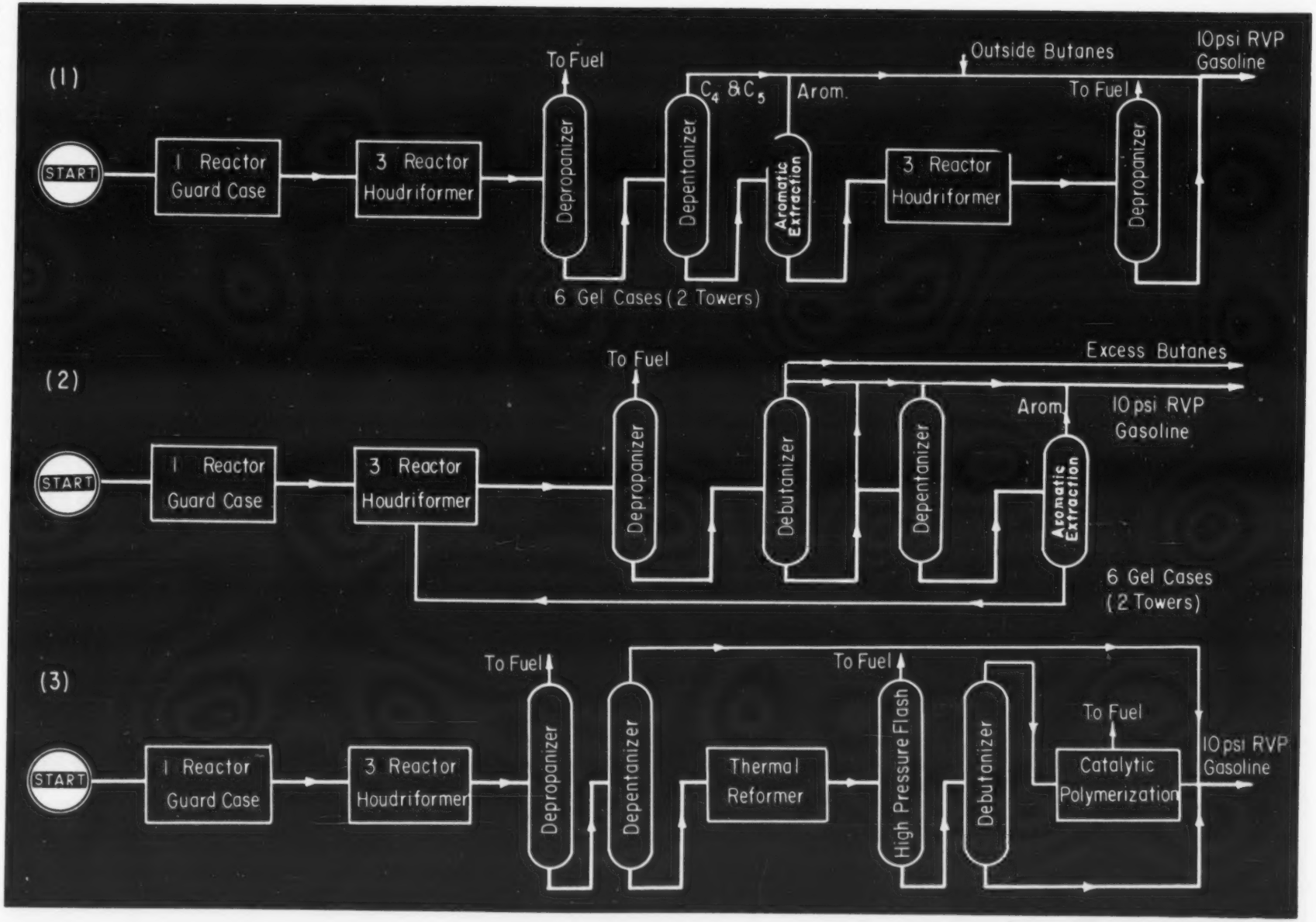
TABLE 1—Inspections of Reformer Charge

Gravity, °API	51.0
Distillation, °F:	
I.b.p.	200
10%	230
50%	295
90%	365
End point	394
Sulfur, Wt. %	0.125
F-1 clear octane	54.1
Composition, Vol. %:	
Paraffins	46
Olefins	—
Naphthenes	37
Aromatics	17

TABLE 2—Comparative Yields and Process Streams of Iso-Plus Houdriforming Processes

	Houdriforming Plus Aromatics Extraction		Houdriforming Plus Thermal Reforming
Reformer Feed, bpsd			
Feed to pretreater	6,600	6,600	6,600
Recycle Raffinate	.....	3,531	.....
Total	6,600	10,131	6,600
Yields from Reforming, bpsd			
Reformate, C_5+	5,003	8,753	5,900
Butanes	271	574	271
Fuel Gas, F.O.E.	422	818	422
Reformate Octane, F-1 Clear	87.0	83.0	87.0
Charge to Debutanizer	.....	9,327	6,171
Charge to Dependanizer	6,171	7,068	.....
Dependanizer Bypass Stream	.....	1,685	.....
Charge to Aromatics Separation	5,603	6,545	.....
Aromatic Concentrate	3,174	3,014	.....
Raffinate	2,429	3,531	.....
	Houdriform Raffinate		**Thermal Reform Reformate**
Yields from Second Pass Reforming, bpsd			
Reformate, C_5+	1,832	.....	4,807
Heavy Polymer	.....	.....	33
Butanes	246	.....	143
Butenes, Recovered from Cat Poly Chg.	.....	.....	273
Propene, Recovered from Cat Poly Chg.	.....	.....	183
Fuel Gas, F.O.E.	293	.....	491
Catalytic Polymer Gasoline	.....	.....	328
Reformate Octane, F-1 Clear	81.0	.....	99.6
Over-all Yields:			
Butane Free Gasoline	5,403	5,222	5,135
Butanes for 10-psi R.v.p.	590	529	536
Total 10-psi R.v.p. gasoline	5,993	5,751	5,671
Excess Butanes	73*	45	122*
Fuel Gas, F.O.E.	715	818	913
Gasoline, F-1 Clear Octane at 10-psi R.v.p.	100.0	100.0	100.0

* Outside butanes required.


(1)
START
1 Reactor Guard Case
3 Reactor Houdriformer
To Fuel
Depropanizer
Dependanizer
C_4 & C_5
Arom.
Aromatic Extraction
Outside Butanes
10psi RVP Gasoline
3 Reactor Houdriformer
To Fuel
Depropanizer
6 Gel Cases (2 Towers)
(2)
START
1 Reactor Guard Case
3 Reactor Houdriformer
To Fuel
Depropanizer
Debutanizer
Dependanizer
Aromatic Extraction
Excess Butanes
Arom.
10 psi RVP Gasoline
6 Gel Cases (2 Towers)
(3)
START
1 Reactor Guard Case
3 Reactor Houdriformer
To Fuel
Depropanizer
Dependanizer
Thermal Reformer
To Fuel
High Pressure Flash
Debutanizer
To Fuel
Catalytic Polymerization
10 psi RVP Gasoline

Rexforming—UNIVERSAL OIL PRODUCTS COMPANY

Application: Produces a product having an unleaded Research octane rating ranging upwards from 98-100 when charging a normal, full boiling range gasoline.

Product: The Rexformate product consists of 58 percent or more aromatics, approximately 5 percent naphthenes, olefins in trace amounts. The balance is high-octane, relatively low-boiling paraffins.

Description: Rexforming is a combination process, as indicated in the flowsheet, employing elements of the UOP Platforming method of catalytic reforming in conjunction with some steps of the Udex technique for recovering aromatics.

When charging a full boiling range gasoline, a prefractionator is used to prepare a 180 or 200 degrees IBP to 400 degrees EP heart cut as a side-stream which constitutes feed to the catalytic section. This section employs the Platforming catalyst and flow through it is similar to that in the catalytic section of a Platforming unit. The reactor effluent is flashed to recover hydrogen produced in the process as net make and for recycling. The remaining liquid is stabilized to desired vapor pressure and initial boiling point.

The stabilized reactor effluent then is contacted countercurrently in a specially designed extractor column with an aqueous solution of glycol. The overhead, or raffinate, product from this column contains essentially all of the high-boiling, low-octane paraffins. This stream is recycled to the reactor section via the prefractionator feed, whence it appears in the heart cut previously mentioned. The bottom, or extract, product is stripped of dissolved hydrocarbons in the last column. The stripper overhead is Rexformate. The bottom product is solvent of the desired composition to effect the recovery of Rexformate and is recycled to the extractor.

Severe catalytic reforming conditions are unnecessary to secure a "super fuel" from the octane standpoint. This makes for long catalyst life and high yields and reduces equipment maintenance costs in comparison with once-through catalytic reforming to the same octane level.

The extractor column conditions are set to control the quality of the Rexformate, rather than the reactor conditions as in Platforming. Reactor conditions are set for the optimum conversion of hydrocarbons in the total reactor feed into high octane compounds.

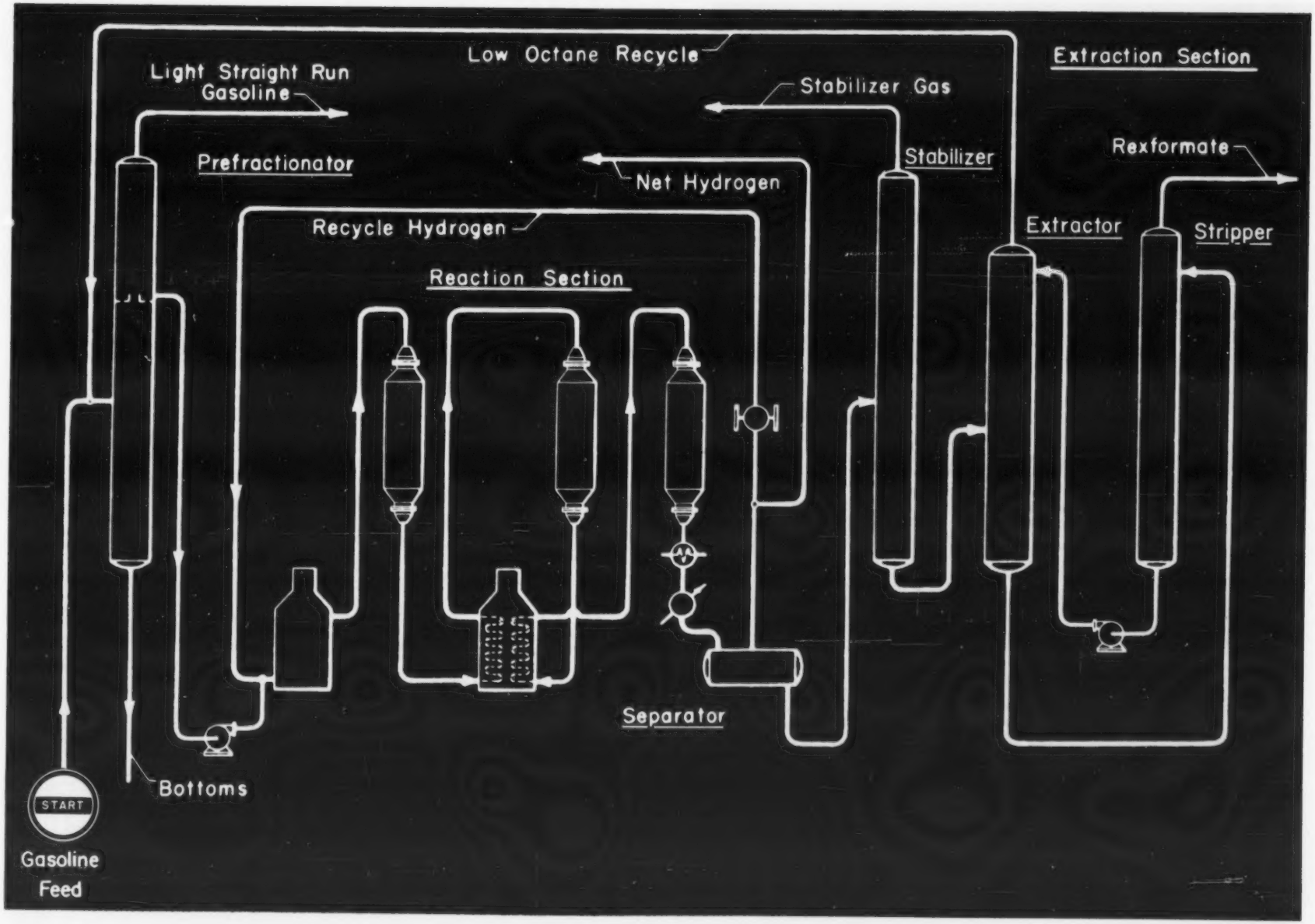
Since the raffinate is a recycle stream rather than a final product in Rexforming, there are no "losses" of high octane materials to a low-quality stream. This permits important equipment simplification and operating economies because the separation between raffinate, and extract need not be extremely sharp.

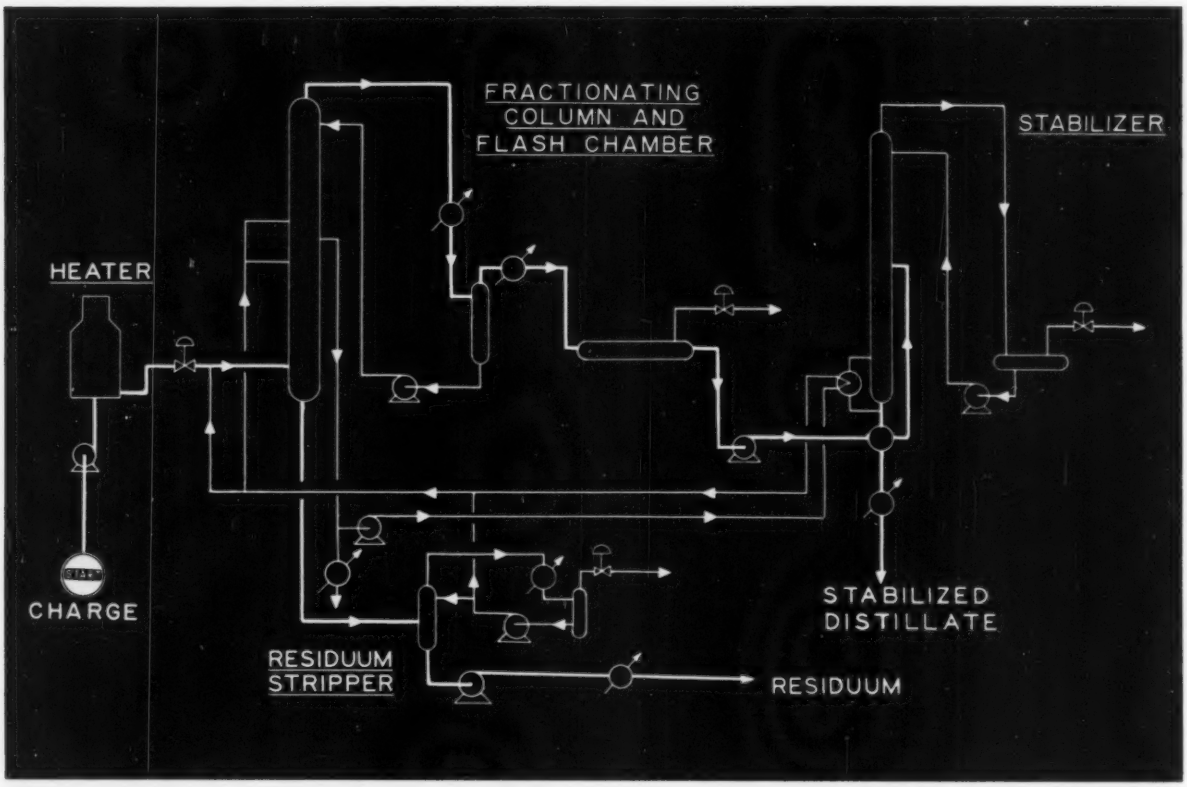
Yields: The superlative quality of Rexformate is indicated in the accompanying data tabulation:

Commercial Installation: Several all-new Rexforming units have been placed on-stream and have demonstrated the capability to produce high quality products. Several Platforming units also have been converted to Rexforming, while a number of other Platformers contain provisions for future conversion to Rexforming.

Reference: PETROLEUM REFINER 34, No. 4, 116 (1955).

	Reactor Combined Feed	Debutanized Rexformate
Gravity, °API	56–58	42
ASTM Distillation:		
Initial Boiling Point F	180	110
10 Percent	215	160
30 Percent	240	210
50 Percent	**260**	**240**
70 Percent	287	275
90 Percent	334	330
End Point	380	410
Sulfur, Weight Percent	0.055	0.001
Hydrocarbon Type, Volume Percent:		
Paraffin	60.5	35
Olefin	Trace	0
Naphthalene	33.5	5
Aromatic	6.0	60
Reid Vapor Pressure	.....	3.6
Octane Rating:		
Research, Clear	.....	98.0 (min.)
+ 3 ml. TEL	.....	iso C_8 + 0.19 ml. TEL
Yield, Volume Percent Fresh Feed, Estimated	.....	81.0


Low Octane Recycle
Extraction Section
Light Straight Run Gasoline
Stabilizer Gas
Prefractionator
Stabilizer
Rexformate
Net Hydrogen
Recycle Hydrogen
Extractor
Stripper
Reaction Section
Separator
Bottoms
START
Gasoline Feed



Thermal Reforming — UNIVERSAL OIL PRODUCTS COMPANY

Application: Converts low-octane gasolines and naphthas into higher-octane gasoline. It also produces butane-butylenes and propane-propylene which can be polymerized to produce a high-octane polymer gasoline. The residuum from Thermal Reforming has a high calorific value, and can be marketed as fuel oil.

Description: A straight-run gasoline or naphtha fraction is charged to a heater wherein the reaction time, pressure, and discharge temperature are controlled to produce the desired products. The effluent from the heater passes through a pressure control valve where the pressure is reduced. A quench stream from the fractionator is introduced after the control valve to reduce the temperature of the effluent and minimize coking.

The quenched products enter a combination flash chamber and fractionating column wherein the gas and gasoline are taken overhead, and the small amount of bottoms produced is removed from the lower portion of the vessel. A cracked naphtha sidecut from this column is used for quench and heat exchange duty. Naphtha sidecuts may be withdrawn if desired.

The overhead products from the fractionator are cooled, and the condensed, unstabilized gasoline is sent to a stabilizer to produce the desired vapor pressure. If polymerization of the gases evolved from the cracking operation is desired, an absorber for the receiver gases plus deep stabilization of the gasoline is employed to provide maximum recovery and utilization of polymerizable olefins available.

The bottoms withdrawn from the flash chamber portion of the reformer column are further flashed in a residuum stripper. Light overhead material removed from the residuum at this point is condensed and returned to the fractionating column, whereas the residuum is sent to storage for subsequent disposal as fuel oil. The properties of the residuum are regulated by suitable control of reflux to the stripper.

Yields: A typical result when reforming a 53° API Mid-Continent straight-run naphtha is shown below.

Charging Stock:	
Gravity, ° API	53.0
F-2 O.N., Clear	40.5
Characterization Factor	11.96
100 Ml. Distillation, ° F.:	
Initial Boiling Point	208
10 Percent	263
50 Percent	**314**
90 Percent	367
End Point	389
Products:	
Gasoline:	
Yield, Volume Percent of Charge	81.3
Gravity, ° API	56.1
RVP, Psi	10.0
100 Ml. Distillation, ° F:	
Initial Boiling Point	93
10 Percent	145
50 Percent	**270**
90 Percent	360
End Point	398
Octane Ratings:	
F-2 O.N., Clear	70.2
+ 3 ml. TEL/Gallon	81.9
F-1 O.N., Clear	78.2
+ 3 ml. TEL/Gallon	91.3
Residuum:	
Yield, Volume Percent of Charge	4.2
Gravity, ° API	18.2
Gas:	
Yield, Weight Percent of Charge	15.3
Cu. Ft./Barrel of Charge	467

Alkylation

ALKYLATE is second to reforming as a means of getting economical octanes. The alyklate will have an F-1 octane rating of around 95 unleaded. Its outstanding characteristic, however, is its relatively high F-2 rating—about 93. This quality is very desirable to compensate partially for the high sensitivity imparted to a gasoline blend by reformed and cracked components.

The continued interest in F-2 ratings of motor fuels is generated by trends in automobile engine designs. As the compression of an engine is increased to achieve more power, the engine has a greater tendency to knock at high speeds. The F-2 rating of a fuel is a measure of its ability to satisfy high-speed octane requirements of an engine. Therefore, the refiner wants some gasoline components to have high F-2's.

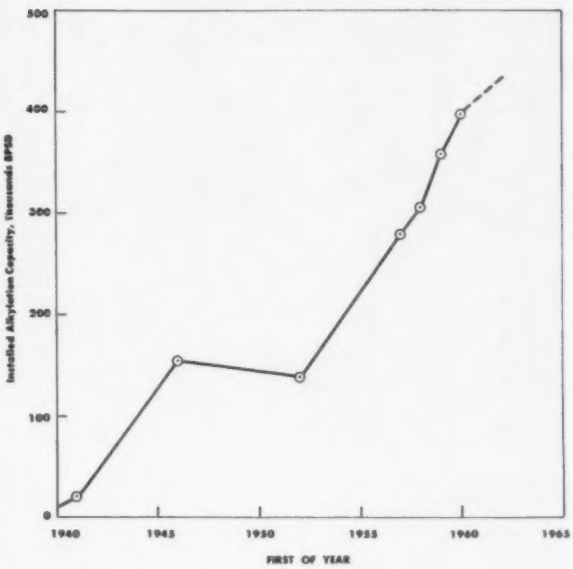
The value of alkylate as a motor fuel blending component is shown in the accompanying table. Road ratings are estimated in order to show how much better alkylates are for furnishing high octanes. The average premium grade gasoline is based on fuels sold during July 1960.

The growth of alkylation capacity in the U.S. can be seen in the accompanying graph. Aviation gasoline demands of World War II caused plant capacities to mushroom from nothing in 1938 to 158,000 barrels per day in 1946. After the war, the demand for aviation alkylate dropped so that between 1946 and 1951 about half of the plants were shut-down and several were dismantled.

In 1951 the Petroleum Administration for Defense began pushing for additional alkylation capacity. However, more recent installations are being made to satisfy the demands for high octane motor fuel components.

The principle of alkylation as it applies to motor fuel production involves the combination of an isoparaffin, usually iso-butane, with olefins such as propylene, butylene and amylene. The resulting product is a gasoline component with very desirable stability properties and high octanes.

Recent emphasis has been on the modification of existing processes to permit charging larger quantities of propylene. Heretofore, butylene has been the major charge olefin. The switch to propylene and amylenes will give more material for refiners to supplement their olefin supply.



The catalysts used commercially for alkylation are sulfuric acid, hydrofluoric acid, and aluminum chloride promoted with hydrochloric acid. The reaction may be achieved thermally; however, a pressure of 3000-8000 psig is required. On the other hand, if catalyst is used, much lower pressures may be employed. Sulfuric acid alkylation units, for instance, usually are operated at near atmospheric pressure.

Temperature is another important variable in alkylation. If the temperature is allowed to exceed 70 F in sulfuric acid alkylation, oxidation of the hydrocarbons occurs to such an extent that acid consumption is increased. With hydrofluoric acid, higher temperatures are permitted, although better octane ratings are achieved at lower temperatures.

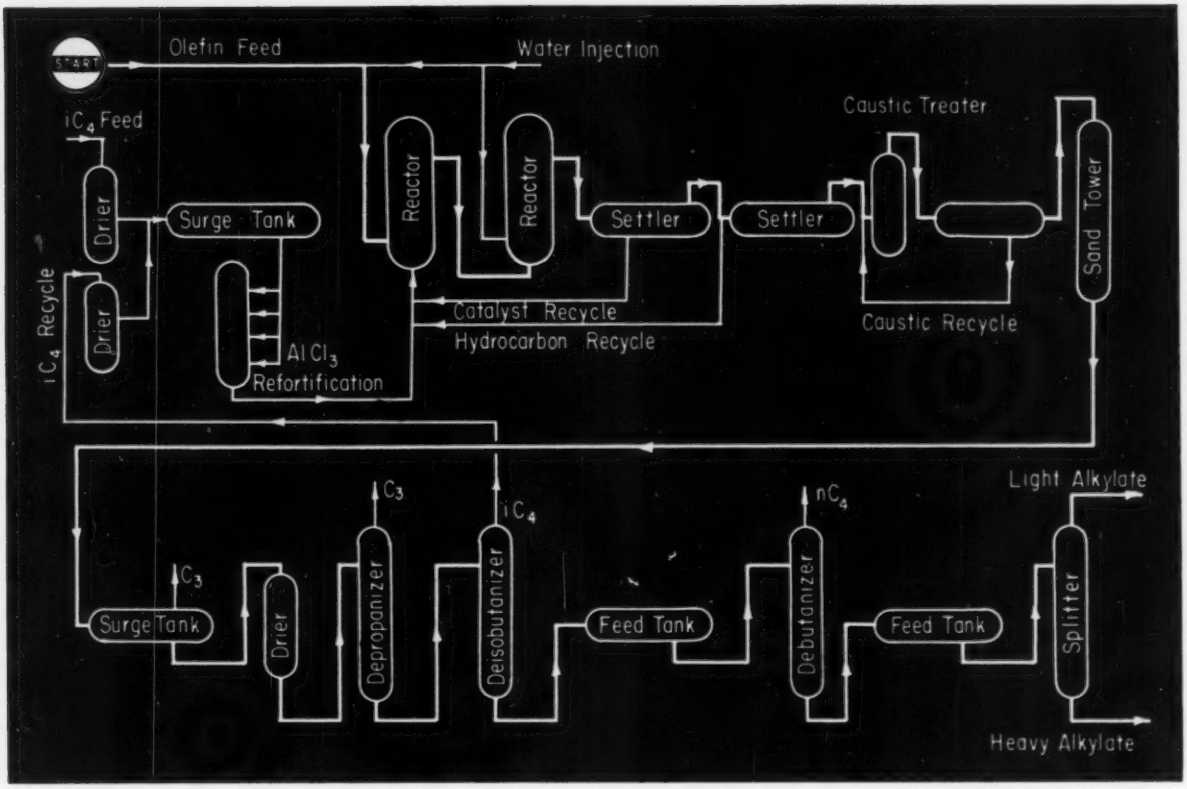
Other applications of alkylation, besides production of a gasoline blending component, are production of petrochemicals. Ethyl benzene is an example of such a petrochemical. It is produced by combining benzene with ethylene. The product is used in the formation of styrene and synthetic rubber. More of these applications are covered in the Petrochemical Handbook which was published by PETROLEUM REFINER in November 1959.

More details on the alkylation process as a source of motor fuel blending components is given in the comprehensive article by R. E. Payne in "Alkylation—What You Should Know About This Process," PETROLEUM REFINER 37, No. 9, 316-329 (1958).

How Alkylate Compares

Motor Fuel	Laboratory O.N. +3cc TEL		Estimated Road O.N.		
			Modified Borderline At RPM Given		
	Research (F-1)	Motor (F-2)	2,000	3,600	Modified Uniontown
Alkylate.....	103	104	108	106	107
Reformate....	103	94	103	103	103
Premium Grade[1].....	99.4	89.7	99	95	99

[1] Average for July, 1960.



Aluminum Chloride Alkylation — PHILLIPS PETROLEUM COMPANY

Application: For conversion of normally gaseous hydrocarbons to high octane motor fuel.

Charge: Ethylene propylene and isobutane.

Product: A high quality material boiling in gasoline range.

Description: Dry fresh feed is charged to a stirred reactor. Intermittent addition of catalyst to the system is accomplished by passing the isobutane charge through a catalyst make up drum. The reactor effluent passes through a primary settler for phase separation of hydrocarbon and catalyst. The catalyst is recirculated to the primary reactor.

A major portion of the effluent from the primary settler is recycled through a cooler to the first reactor for control of effluent temperature from the second reactor in the range of 120° F. The reactors normally operate with a 3 degree rise in temperature.

The remaining portion of hydrocarbon from the primary settler passes to a second settler for final removal of any entrained catalyst then to a caustic washer before entering the fractionation section.

Catalyst employed is aluminum chloride existing as a hydrocarbon complex. HCl is an active promoter of catalyst activity and is produced by injecting a controlled amount of water into reactors.

Propane and lighter hydrocarbons are yielded as an overhead gas from a depropanizer, isobutane is yielded overhead from a deisobutanizer and recycled to the reactors. The bottom product from the deisobutanizer is fractionated for end point control in an alkylate splitter.

Operating Conditions:

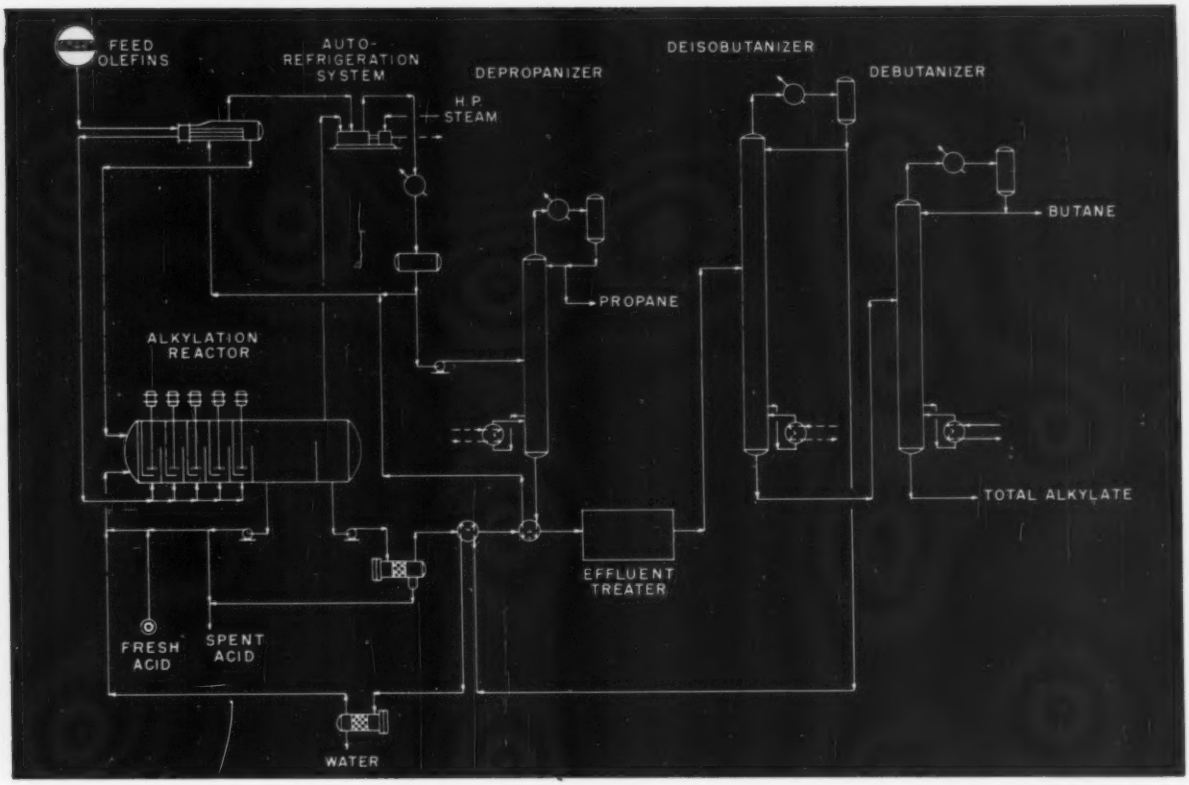
Olefin Feed Components, Mole %	
Methane	12.5
Ethylene	45.2
Ethane	15.8
Propylene	23.2
Propane	2.7
Butane	0.6
Total	100.0
Motor Alkylate Properties	
Yield, % of total alkylate	95.0
R.v.p. (undebutanized)	9.0
°A.P.I.	74.0
A.S.T.M. distillation, °F.	
I.b.p.	110
10 percent	129
20 percent	140
50 percent	159
90 percent	300
95 percent	363
E.p.	425
F-1 octane number:	
Clear	95.1
1 cc TEL/gal.	*102.7
3 cc TEL/gal.	†109.5

* Equivalent of A.S.T.M. Research method rating of 0.15 ml. TEL in isooctane.

† Equivalent of A.S.T.M. Research method rating of 1.10 ml. TEL in isooctane.

Economics: Investment cost for a battery limits plant based on an operation to produce motor fuel alkylate will range from approximately $1300 to $550 per barrel for alkylate productions of 1,000 bpd to 10,000 bpd, respectively. Utilities and chemicals requirements are given in the accompanying table.

	Unit/Bbl. Total Alkylate
Utilities	
Steam (million Btu absorbed)	0.44
Cooling-water circulation, 1000 gal. 20° rise	2.6
Makeup water, 1000 gal.	0.08
Power, kw-hr.	3.3
Chemicals	
Caustic, lb.	0.015
Aluminum chloride, lb.	2.80



Cascade Sulfuric Acid Alkylation — THE M. W. KELLOGG COMPANY

Application: Converts refinery olefins to gasoline by selective reaction with isobutane in the presence of sulfuric acid catalyst.

Charge: Propylene, butylenes and amylenes from any source and isobutane.

Product: Superior octane alkylate for aviation or motor gasolines, capable of imparting exceptional road performance and freedom from combustion chamber deposits.

Description: The cascade process has been developed to minimize side reactions which cause degradation of acid and loss of quality. The reaction conditions include:

1. High isobutane concentration;
2. Low olefin concentration;
3. Moderate temperature.

In the Cascade System dilute olefin concentration is achieved by splitting the olefin feed into a number of parallel streams each of which is fed to a separate reaction compartment containing its own mixer. Low temperature is maintained by allowing vaporization in each zone to remove heat of reaction. This auto-refrigeration provides a more efficient refrigeration cycle than would be possible if heat exchange or pressure reduction systems were used. The condensed refrigerant is depropanized and mixed with recycle isobutane and acid catalyst. This mixture flows in series through the reaction compartments, achieving the effect of many reactors each receiving the total recycle and all of the refrigerant isobutane which will vaporize in later zones. The effect of this arrangement on the isobutane content and isobutane/olefin ratio are shown in the accompanying table. These high ratios could not have been achieved if the isobutane and olefin streams were mixed prior to entering the reactor system.

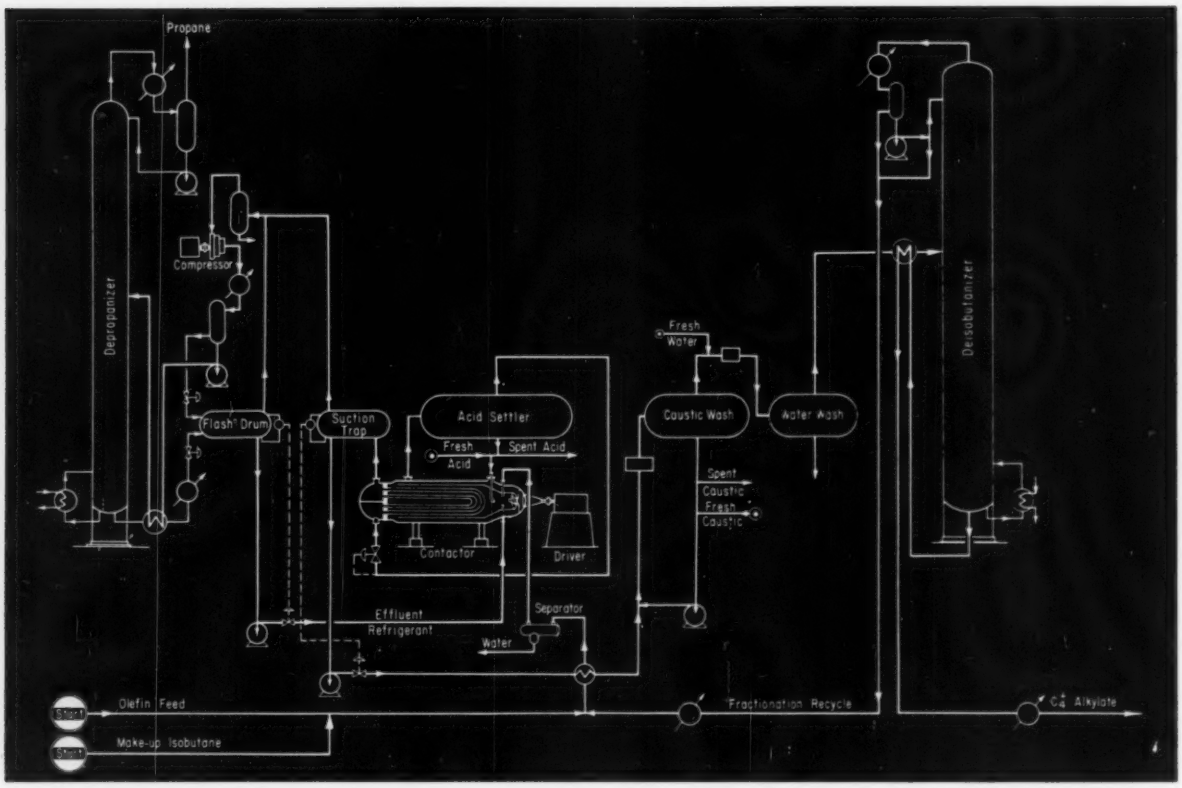
Reactor effluent, which contains the reaction products, recycle isobutane, and inert components of the feed, is separated from the acid catalyst in the settling zone of the reactor, treated to remove entrained acidic materials and fractionated to separate isobutane recycle and butane product from total alkylate.

Operating Conditions: Typical operating conditions for a five-zone Kellogg Cascade reactor are given in the following table:

Zone No.	% iC_4	iC_4/olefin ratio (external)
1	83.0	30.5
2	76.0	26.2
3	68.5	22.1
4	59.8	18.1
5	50.5	14.3
Average	67.6	22.2
Temperature	50° F	
Fresh Acid strength	99%	

Olefin Feed Type	Propylene	40%C_3—60%C_4—	Butylenes	Pentenes
Yield-Bbl. Alkylate per bbl. olefin	1.78	1.74	1.72	1.60
Isobutane Consumption, Bbl. per Bbl. Olefin	1.28	1.18	1.11	0.97
Acid Consumption Lbs. per Gal. Alkylate	2.5–0.84	1.5–0.6	0.84–0.33	1.0–0.4
338° F End Point Alkylate Quality:				
F-1 O.N., Clear	89–92	92–95	94–97	90–93
+3.0cc TEL/Gal.	101.5–103.0	103.5–105.0	104.2–106.3	103–103.6
F-2 O.N., Clear	87–90	90–93	92–94	90–92
F-3 (1-C) P.N.,				
+4.6cc TEL/Gal.	117–122	124–127	127–132	116–123
F-4 (3-C) P.N.,				
+4.6cc TEL/Gal.	129–142	141–154	150–165	136–148

Commercial Installations: A total of 38 alkylation units have been engineered, designed or are underway by Kellogg.



Effluent Refrigeration Alkylation — STRATFORD ENGINEERING CORPORATION

Application: Combines propylene, butylenes, and amylenes with isobutane in the presence of strong sulfuric acid to produce high octane branched chain hydrocarbons (alkylate) for use in aviation gasoline and motor fuel. Effluent Refrigeration is essentially a means of obtaining economically a very high concentration of isobutane in the reaction mixture with little conventional isobutane fractionation. It may be applied to new plants, or to existing alkylation plants, for the production of higher quality alkylate or for increased production.

Product: Most of the recently installed plants and the majority of those being currently installed are designed to process a mixture of propylene and butylene. The total debutanized alkylate from these plants has F-1 octane numbers of 92-96 clear and 103-107 with 3 cc TEL. When processing straight butylenes, commercial installations are producing debutanized total alkylates having F-1 octane numbers as high as 99.0 clear and 115.0 with 3 cc TEL. Endpoints of the total alkylates from both mixed feeds and straight butylene feeds have averaged between 340° F to 390° F in most cases. The alkylates may be rerun to produce 96-99 percent of 338° F endpoint aviation alkylates having 3-C performance numbers of 150-165 (4.6 cc TEL).

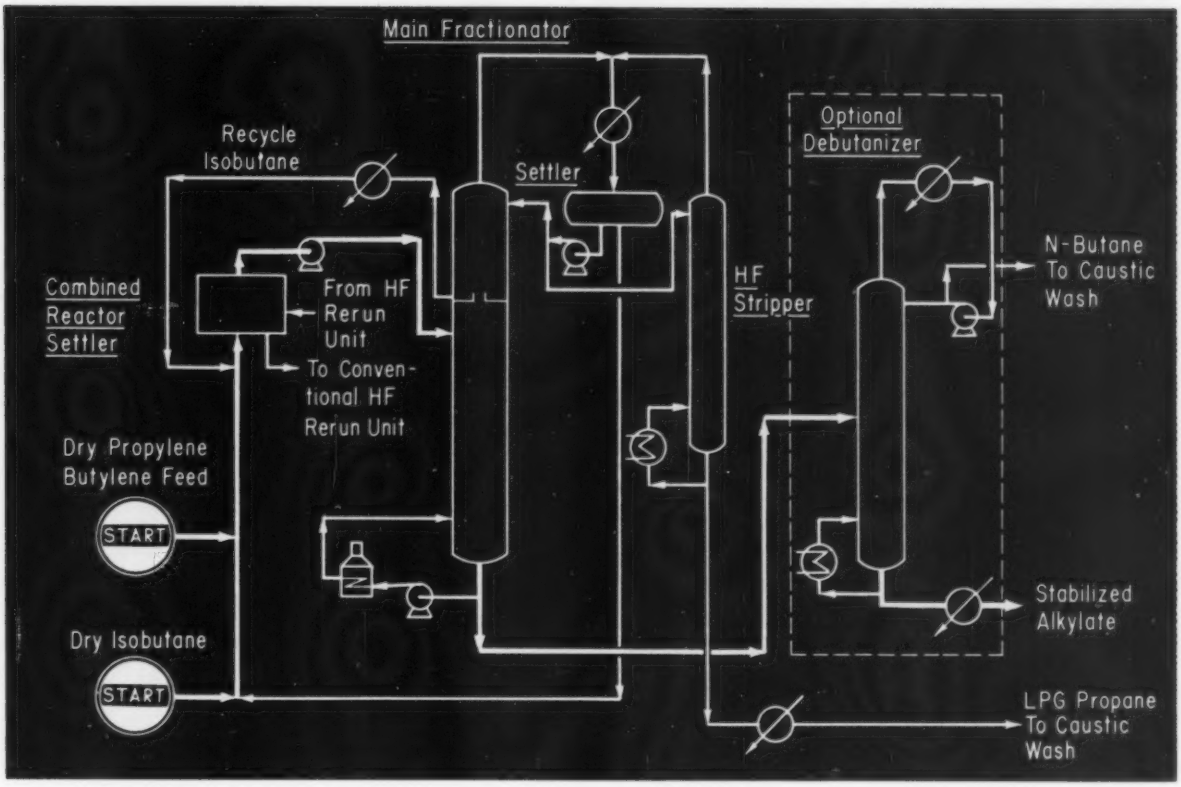
Description: The feed streams along with a recycle stream of H_2SO_4 are charged to the contactor. The liquid contents of the contactor are circulated at high velocities and an extremely large amount of interfacial area is exposed between the reacting hydrocarbons and the acid catalyst. The entire volume of the liquid in the contactor is maintained at a uniform temperature. The maximum deviation between any two points within the reaction mass is less than 1° F.

The overhead from the deisobutanizer and the effluent refrigerant recycle together constitute the total isobutane recycle to the reaction zone. Normally, approximately 60 percent of the external isobutane recycle comes from the effluent refrigeration recycle and only 40 percent from the deisobutanizer. No portion of the isobutane recycle is permitted to vaporize from the reaction zone. The total quantity of isobutane recycle is present in liquid phase throughout the reactor, thereby serving to promote the alkylate reaction to the same extent as equivalent isobutane from a deisobutanizer. Isobutane concentration in the hydrocarbon phase leaving the reactor normally ranges between 60 and 80 volume percent.

Alkylates produced by effluent refrigeration normally have an endpoint sufficiently low so that if the alkylate is to be used for motor fuel it need not be rerun.

Commercial Installations: Twenty-six commercial plants employing effluent refrigeration are now in operation and three are under construction.

Reference: Petroleum Refiner 38, No. 9, 166 (1959).



HF Alkylation, Perco—PHILLIPS PETROLEUM COMPANY

Application: To convert propylene butylenes and isobutane to highest quality motor fuel alkylate.

Description: The essential features of the process are shown in the flow diagram. With minor variations this design may be used with widely different feedstocks to produce either motor fuel or aviation alkylate.

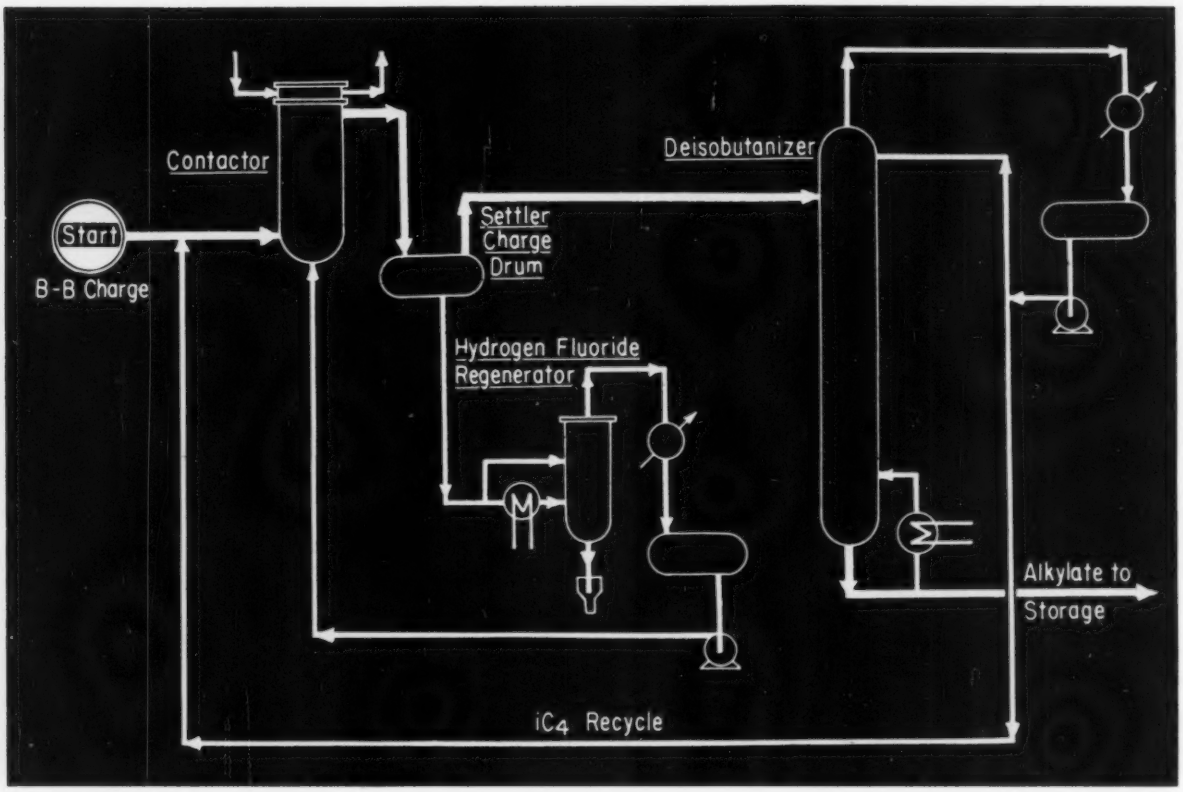
Dry liquid feed containing olefins and isobutane is charged to a combined reactor settler of exclusive Phillips' design. The hydrocarbon phase which is produced in the settler is fed to the main fractionator which accomplishes the needed separation to LPG quality propane product, alkylate product and a recycle isobutane. Small amounts of dissolved HF are removed from the propane product by the HF Stripper, a small tower.

Stabilization of the alkylate product to remove normal butane content can be accomplished by a main fractionator vapor side stream, if desirable or necessary. Alternately, a debutanizer may be provided for complete removal of *n*-butane from the alkylate.

As an auxiliary to the operation a very small acid rerun unit is provided for continuous purification of a slip stream of reactor acid.

Yields: A typical operation is shown for a propylene-butylene cut from a catalytic cracking operation based on 100 barrels total feed.

Charge to Unit, Barrels	
Propane	15.3
Propylene	9.9
Butylene	19.6
Isobutane	37.9
n Butane	17.3
	100.0
Yields, Barrels	
Propane	16.7
Isobutane	1.2
n Butane	17.3
Alkylate	52.2
	87.4
Debutanized Motor Fuel Alkylate:	
Gravity, °API	71.5
R. v. p., psi	4.5
ASTM Distillation, °F	
IBP	120
50% evap.	212
E. P.	355
Color, Saybolt	30
Doctor Test	Negative
Corrosion, 122° F	Negative
ASTM Gum, mg/100 ml.	0.4
Research Octane Number	
Clear	94.0
+ 3cc TEL/gal	106
Motor Octane Number	
Clear	91.8
+ 3cc TEL/gal	107
Operating Service Factor: 98%	



HF Alkylation — UNIVERSAL OIL PRODUCTS COMPANY

Application: For combining an isoparaffin with an olefin, or olefin mixtures, to form a highly-branched high octane paraffinic product.

Charge: Isobutane may be alkylated with propylene, butylenes, amylenes, or even higher boiling olefins. Butylenes, or butylenes-plus-propylene are the most common olefin charge stocks.

Description: The process flow diagram shown is for the production of motor fuel alkylate. Additional equipment required for an aviation alkylate includes a rerun column, debutanizer and a depropanizer.

Acid consumption is no higher for propylene and amylenes than for the butylenes. There is no acid disposal problem. This process is excellent for making the 100-plus octane components for aviation and motor fuel blending.

The incoming charge, usually a mixture of isoparaffin with a controlled amount of olefins, is mixed with additional isoparaffin as recycle and then is brought into intimate contact with the HF catalyst. The effluent is settled. The bottom product, hydrogen fluoride, is sent to regeneration and then recycled to the contactor. The settler overhead product is deisobutanized, the bottom product being alkylate which is washed with dilute caustic and sent to storage.

Product and Yields: Requirements of isobutane, alkylate product qualities and yields when charging butylenes and propylene are shown in Table 1. Analytical data and antiknock ratings for a rerun butylene alkylate are shown in Table 2.

TABLE 1

	Vol./Vol. Olefin		Research Octane No.		Motor Octane No.	
	Isobutane	Alkylate	Clear	+ 3 ml. TEL/Gal.	Clear	+ 3 ml. TEL/Gal.
Butylenes	1.16	1.75	96+	iso + 0.9 ml. TEL	94	iso + 0.9 ml. TEL
Propylene	1.33	1.77	93	iso + 0.3 ml. TEL	91	iso + 0.35 ml. TEL

TABLE 2

Gravity, °API	71.6
RVP, psi	4.3
Total Alkylate, Volume Percent	97.5
Engler Distillation, °F.	
I.B.P.	102
10 Percent	176
50 Percent	**217**
90 Percent	231
E.P.	336
Antiknock Ratings with 4.6 ml. TEL/Gal.	
F-3, Performance Number	129.3
F-4, Iso + ml. TEL/Gal	3.9
F-4, Performance Number	152.0

Commercial Installations: Commercial units range in capacity from 622 to 7,000 bpsd. Installation costs for motor alkylate plants run from $700 to $1000 per barrel in sizes down to 500 bpsd of 3.5 psi RVP product, depending upon capacity and feed preparation required.

Reference: Jones, E. K., "Commercial Alkylation of Paraffins and Aromatics," *Advances in Catalysis,* X, 165-195, Academic Press, Inc., New York (1958)

Isomerization

ISOMERIZATION is the latest processing technique available for getting higher octane motor fuels. It can be used to convert the light gasoline materials into their higher octane isomers. Another route to higher octanes, through somewhat indirect is the use of the process to convert normal butane into the iso-butane needed for alkylation. To date the greatest application of isomerization is for the production of iso-butane.

Iso-butane is needed for an alkylation feed because alkylation can often consume more iso-butane than occurs naturally in a refinery stream. For instance, here is a typical analysis of a C_4 fraction from a reforming operation:

Reformer Off-Gas

Component	Wt. %
iso-Butylene	20
n-Butylenes	27
iso-Butane	18
n-Butane	35
Total	100

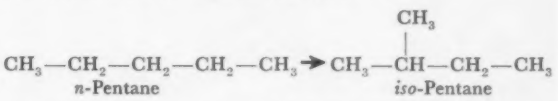
In an alkylation reaction the 47 percent total olefins are capable of uniting with about an equal amount of iso-butane, although only 18 percent is available in the stream. Also, as alkylation units are modified to permit the use of more propylene and amylene, even larger quantities of iso-butane will be needed.

For a motor fuel, often the light materials in the blend have the lowest octanes. Therefore, isomerization has another way it can do its bit for the octane fight. By converting some of the light materials to their isomers, an increase in octane rating is achieved. The octane comparison in the accompanying table shows the improvement which would accrue from isomerizing normal-pentane and normal-hexane.

The first to install an isomerization process for the production of a motor fuel blending component was Atlas Processing Company in Shreveport, La. Its unique refinery charge of natural gasoline made the process worthwhile for the conversion of hexane. The first pentane isomerization unit was installed at Borger, Texas, for Phillips Petroleum Co.

Some refiners do not believe a separate isomerization process is needed to handle the light fractions of gasoline. They suggest the stocks be charged along with a normal reforming process. Some isomerization will occur and the loss in reformer product octane is compensated for by the increased quantity of material produced.

The reaction which occurs during isomerization may be represented by the following symbols:



The reaction is carried out in a hydrogen atmosphere in order to hydrogenate any slight amount of cracked materials which may be formed as side-reactions to the process. The isomerization reaction neither consumes nor produces hydrogen.

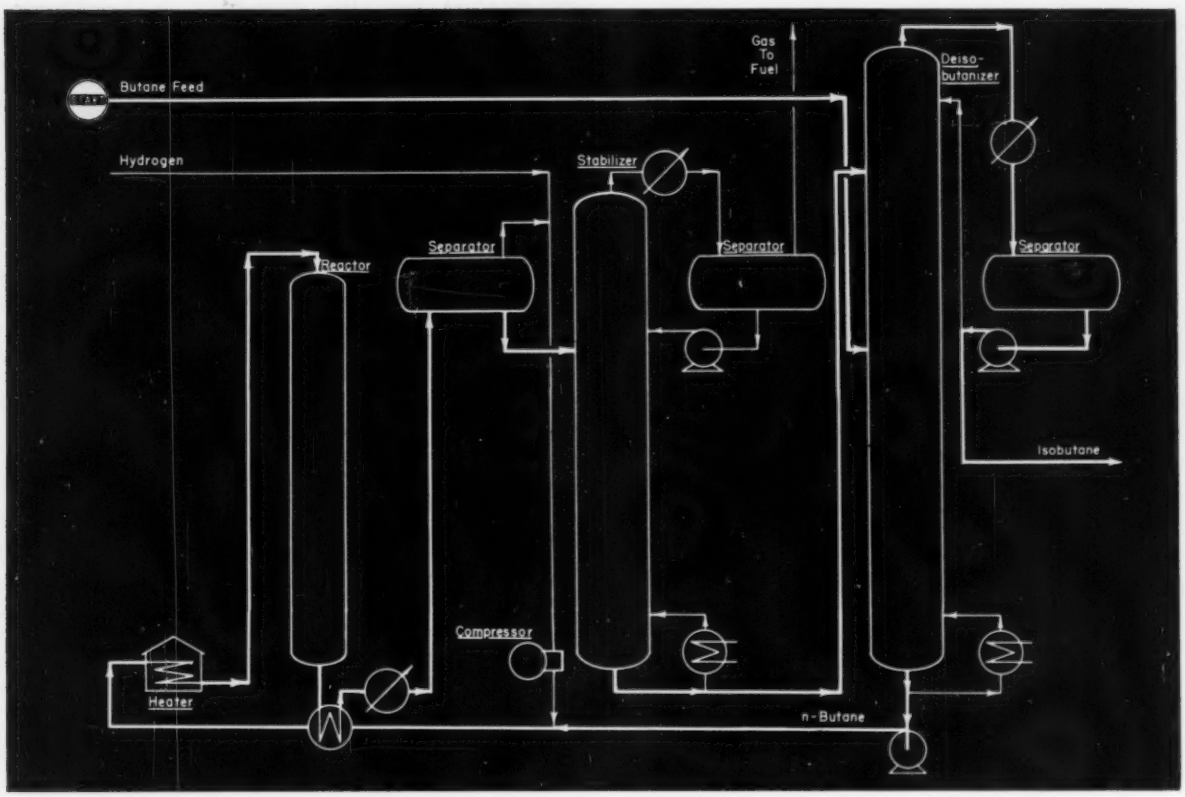
Only one new isomerization has been announced since the 1958 edition of this Handbook. However, insufficient processing data are revealed to date; therefore, this process is not included in this edition. The process descriptions included here are as follows:

- Butamer
- Catalytic Isomerization
- Iso-Kel
- Isomerate
- Liquid-Phase Isomerization
- Penex
- Pentafining

Of these some are designed for the isomerization of butane while others are tailored for the conversion of pentanes and heavier materials.

How Isomerization Ups Octanes . . .

Charge	F-1 OCTANE NUMBER Clear	F-1 OCTANE NUMBER +3cc TEL	Isomers	F-1 OCTANE NUMBER Clear	F-1 OCTANE NUMBER +3cc TEL
n-Pentane	61.7	88.7	iso-Pentane	92.3	103.5
n-Hexane	24.8	65.3	2-Methylpentane	73.4	93.1
			3-Methylpentane	74.5	93.5
			2, 2-Dimethylbutane	91.8	104.3
			2, 3-Dimethylbutane	102.6	107.8



Butamer — UNIVERSAL OIL PRODUCTS COMPANY

Application: For economically converting normal butane to isobutane under mild processing conditions by means of a catalyst in the presence of hydrogen.

Product: The once-through product approximates equilibrium concentrations of isobutane; in recycle operation, product is high purity isobutane.

Catalyst: A stable, rugged, long-lived, non-corrosive solid containing platinum, capable of functioning efficiently at relatively low operating temperatures for long periods of time.

Description: A typical unit is illustrated in the simplified flow diagram. Mixed butane feed is charged to a deisobutanizer, concentrating the normal butane in the bottom product. Next, the butane is mixed with hydrogen (conveniently obtained from a reforming unit), heated and charged at moderate pressure to the reactor containing the special catalyst. The reactor effluent is cooled, hydrogen and light gases are separated from the liquid in a separator for recycling via a compressor, and the liquid then is stabilized in a conventional column. The stabilized bottom product is deisobutanized and high purity isobutane is taken overhead as product, together with any isobutane introduced in the fresh feed. A small chemical hydrogen consumption results from the formation on minor amounts of methane, ethane and propane. A small quantity of hydrogen also appears in the stabilizer overhead gas; it represents the so-called "solution loss." The hydrogen-to-charge ratio is low.

Yields: When yields are computed on a volumetric basis, starting with 100 volumes of normal butane, the ultimate yield is greater than 100 vol. %.

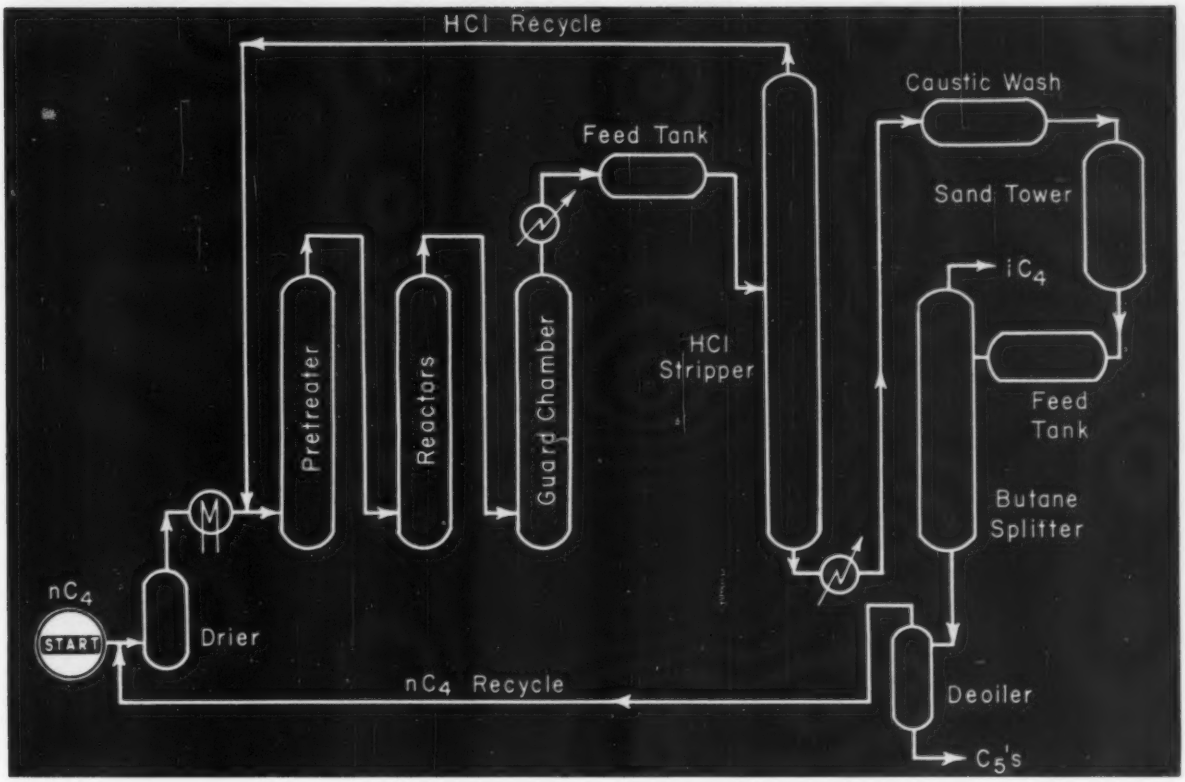
Economics: Process investment and operating costs are given in the table for a plant producing 2,000 bpsd of isobutane product. Roughly a third of the investment is represented by the deisobutanizer but, normally, a Butamer unit would be integrated with an alkylation unit—in new construction, particularly—and thus it may be designed as a single column to meet the combined requirement of both units.

Commercial Installations: Two units presently are operating and a third is being built. Capacities range from 1,500 to 3,400 barrels of product daily.

Butamer Process Economics

Process Investment, 2,000 bpsd isobutane product		$1,300,000
Operating Costs, ¢/gal. isobutane:		
Labor	0.25	
Utilities	0.75	
Catalyst	0.25	
Maintenance, taxes, etc	0.20	
	1.45	

Reference: *The Oil and Gas Journal* 56, No. 13, 73 (1958).



Catalytic Isomerization — PHILLIPS PETROLEUM COMPANY

Application: Isomerization of normal butane to produce a high-yield, high-purity isobutane is performed by a vapor phase catalytic treatment of dry normal butane wherein the catalyst utilized is aluminum chloride promoted with HCl.

Description: The dry normal butane feedstock is first vaporized and superheated and then, after being mixed with recycle HCl vapors, is fed to a pretreater. The pretreated feed next passes to the reactor.

The pretreater and reactor are bed type chambers containing aluminum chloride sublimed on bauxite. The reactor effluent, consisting of isobutane, normal butane and trace side reaction products, passes through a bauxite-filled guard chamber and then is condensed in a series of effluent exchangers. Removal of trace noncondensables from the liquid effluent stream is performed in a vent gas absorber. The HCl is removed as an overhead vapor from the stripper and recycled to the feed pretreater.

The bottoms product from the stripper passes through a caustic washer and sand filter before being charged to the fractionation section which consists of a deisobutanizer and a deoiler tower. High purity isobutane is yielded as an overhead product from the deisobutanizer. The normal butane overhead product from the deoiler is recycled to the driers. A small quantity of pentane and heavier production is yielded as a bottom product of the deoiler tower.

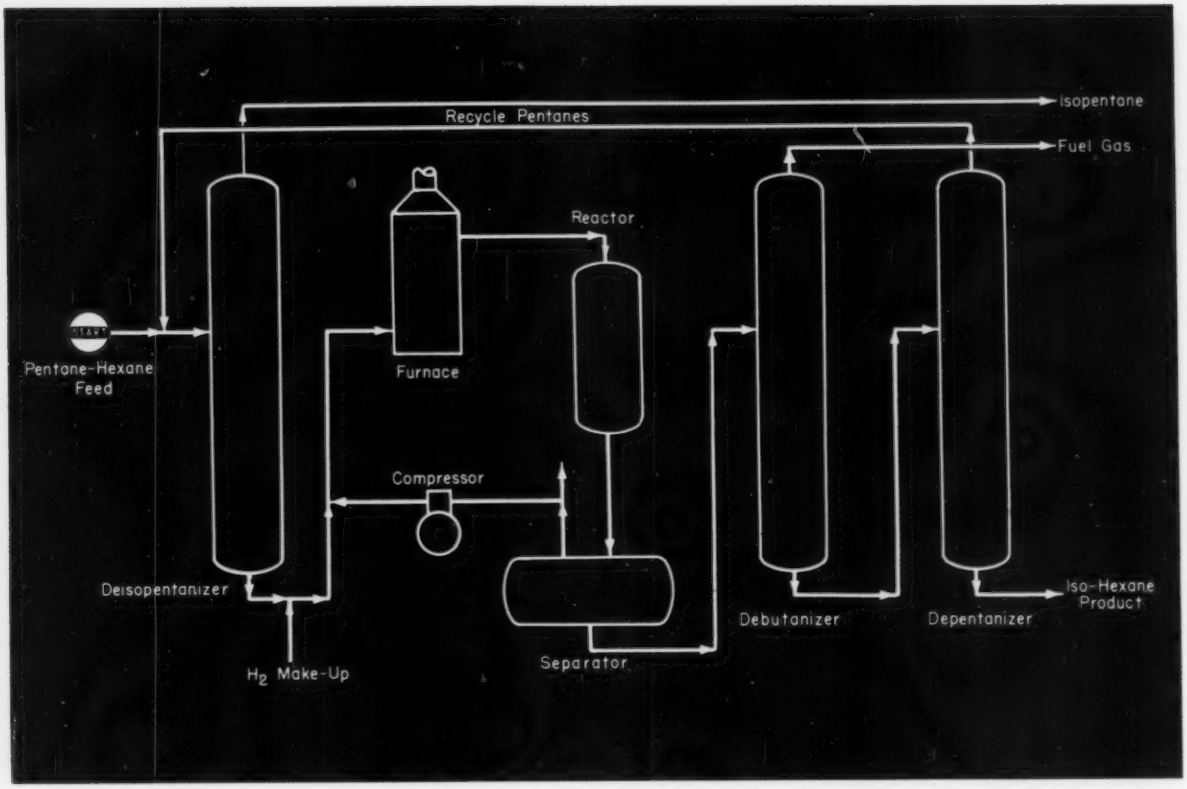
Addition of catalyst to the system is accomplished by subliming aluminum chloride with the hot feedstock and depositing it on the bauxite in the pretreater and the reactor. Make up HCl is injected into the system down stream of the effluent exchangers.

Yields: Typical process information is presented in the following tabulations:

Basis: 100 barrels of charge—50 percent conversion per pass.

	Charge (Bbl.)	Isobutane Yield (Bbl.)	Deoiler Bottoms (Bbl.)	Vent Gas (s.c.f.)
Ethane and Lighter	....	....	....	Trace
Propane	....	5	....	....
Isobutane	2	85	....	....
Normal butane	96	2	....	....
Pentane plus	2	....	8	....
	100	92	8	....

Utilities (Unit/Bbl. Isobutane Produced):	
Water circulation, 1,000 gallons	1.5
Water Make-up, 1,000 gallons	0.045
Power, kw.-hr.	1.54
Steam, 1,000 lb.	0.680
Chemicals (Lb./1,000 Bbl. iC_4 Produced):	
Aluminum chloride	85
HCl	70
Bauxite	440
Driocel for driers	7
Caustic	89



Iso-Kel — THE M. W. KELLOGG COMPANY

Application: For isomerizing low octane pentanes and hexanes to high-octane isoparaffinic blending stock.

Charge: Pentanes and hexanes from crude oil, natural gasolines, condensates, or produced by cracking, reforming or hydrogenation.

Product: Isopentane of 104 leaded octane number and isohexanes of leaded octane up to 93.5 are produced separately for blending flexibility. These stable fuels provide front-end volatility to premium gasolines while reducing sensitivity and contributing exceptonial engine performance characteristics.

Description: Depending upon feed stock quality and degree of upgrading desired, the process scheme will be varied to allow for prefractionation of isomers in the feed and recycle of unconverted material. In simplest form pentanes are processed on a recycle basis and hexanes once-through. However, by the addition of deisohexanizer and dehexanizer the hexanes can be recycled to produce a higher quality isohexane product. The simplified flow diagram shown is suitable for either a pentane operation or a mixed pentane-hexane feed. The unit is divided into two sections; a feed preparation section, and a reaction section.

The feed preparation section consists of three fractionating towers. In the deisopentanizer the recycle pentane stream and the pentane-hexane feed are fractionated to separate an isopentane product of 95 or higher purity. The bottoms from this column are in-charge to the reaction section. Following the reaction system, the liquid is fed to a debutanizer to remove a small quantity of absorbed gas. The bottom product from the debutanizer is charged to the depentanizer in which the unconverted pentanes are removed overhead and recycled back to the deisopentanizer. Depentanizer bottoms are the isohexane product.

The heart of the process is a precious metal catalyst of extreme selectivity developed by Kellogg. Extraneous hydrogen is used to control the pressure in the reaction section and to provide a small hydrogen consumption. While with normal operating conditions catalyst regeneration is not required the Iso-Kel catalyst is capable of regeneration in place.

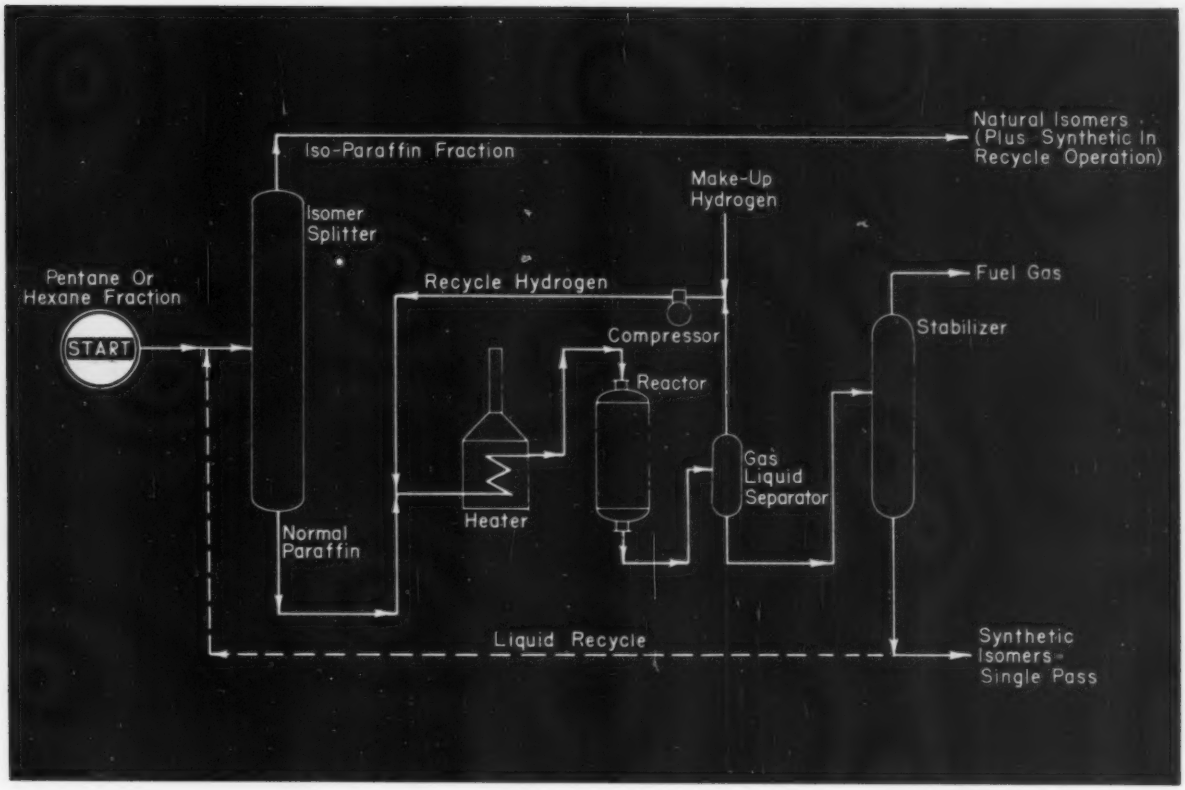
Operating Conditions: The reactor temperature is in the range of 650° F to 850° F and the pressure from 350 to 600 psig. Other process variables are recycle gas rate and space velocity.

Yields: Typical yields and properties of products are shown below. When charging pentanes only the yields of isopentane will be approximately 99 vol. percent.

	Kuwait*		Mid-Continent*		Natural Gasoline†	
MATERIAL	Feed	Product	Feed	Product	Feed	Product
Total C_5 and C_6						
Yield, Volume Percent	100.0	98.6	100.0	98.3	100.0	99.2
F-1 O.N.						
Clear	64.1	79.0	63.0	78.0	73.0	85.7
+ 3cc TEL/gal.	88.2	96.0	86.5	95.0	93.4	99.6
Isopentane Fraction:						
Yield, Volume Percent	45.0	45.0	34.5	34.5	58.5	58.5
F-1 O.N.						
Clear	74.4	92.0	72.9	92.0	79.2	92.0
+ 3cc TEL/gal.	95.8	105.6	94.5	105.6	98.0	105.6
Isohexane Fraction:						
Yield, Volume Percent	55.0	53.6	65.5	63.8	41.5	40.7
F-1 O.N.						
Clear	55.9	68.0	57.7	70.5	64.0	76.4
+ 3cc TEL/gal.	82.0	89.0	82.3	90.0	86.8	93.5

* Recycle of n-pentane and once-through on hexanes.
† Deisohexanising facilities included.

Reference: PETROLEUM REFINER 39, No. 4, 201 (1960).



Isomerate — THE PURE OIL COMPANY

Application: To isomerize low-octane normal pentane and normal hexane to high-octane isomers.

Charge: Include normal pentane and normal hexane from light straight-run naphthas and gasolines, natural gasolines, light catalytic reformate, light catalytic reformate raffinates, and hydro-treated light thermal, coker, or visbreaker naphthas.

Product: The isopentane Isomerate research octane number (3 ml. TEL) approaches 108.6. The actual value depends on the degree of product fractionation. The Isomerate produced from most straight-run napthas (200° F. e.p.) has a research octane (3 ml. TEL) of 94 to 100 plus. This value depends on the feed composition, extent of recycling, and degree of fractionation.

Description: Heart of the process is an active hydrogenation metal catalyst which selectively isomerizes normal pentane and normal hexane to their respective high octane-rating isomers.

The flow diagram illustrates the isomerization section for a pentane or hexane fraction. The high octane isoparaffins are fractionated from the reactor charge and removed as product. The normal paraffins are isomerized. For the recycling operation, the stabilized Isomerate is returned to the reactor charge splitter for separation into isoparaffin product and normal paraffin for recycling.

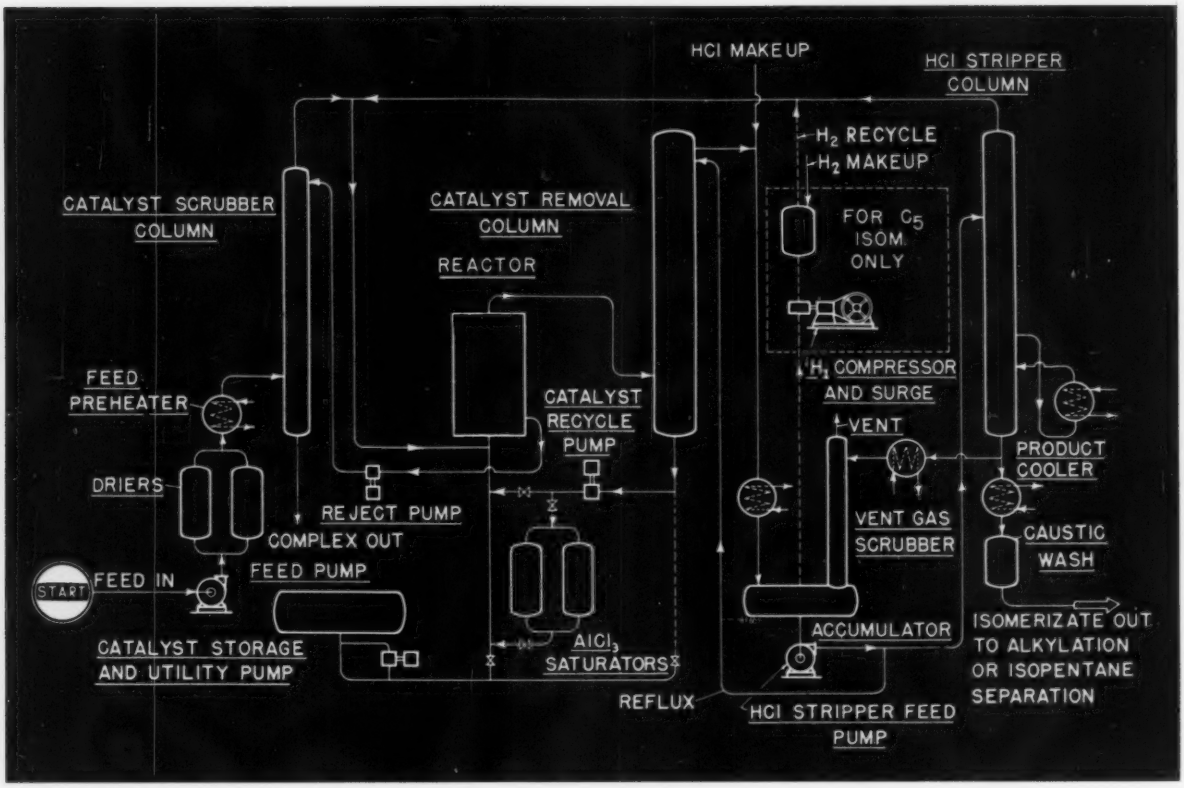
Pentane and hexane fractions may be isomerized jointly or by a parallel arrangement of reaction sections. Feed preparation fractionators are arranged according to the requirements for once-through or recycle operations of the processing scheme employed.

Operating Conditions: High isomerization yields at conversions approaching equilibrium are obtained at mild reactor pressures of below 750 psi. and at temperatures of less than 800° F. Recycle hydrogen ratios are considerably lower than those employed in catalytic reforming, while space velocities are much higher. Only minor quantities of hydrogen are consumed in side reactions since the main function of the hydrogen is to prevent catalyst fouling and deactivation. The isomerization catalyst retains its high activity for a long operating period. The catalyst can be regenerated in place in the event it is fouled due to an operational upset.

Economics: Cost estimates for a Mid-Continent feed are given below. This feed contains a relatively high iso—to normal-paraffin ratio; hence, many other feed stocks can be processed at lower costs. Maximum use of carbon steel is possible since no corrosive products are formed in the vapor-phase reaction.

Processing Scheme	C_5 Isomerization (Recycle)[1]	C_5 Isomerization (Once-through)[1]	Combined[2]
Product, BPCD	4000	6000	10,000
RON, with 3 ml TEL			
Feed	95.9	86.0	90.0
Product	105	92.8	97.7
Investment	$1,820,000	$1,250,000	$3,715,000
Direct operating costs[3]			
¢/gal. product	1.1	0.6	1.0
¢/Δ RON-Bbl (+3 ml TEL)	5.4	4.2	5.6

[1] Includes iso-normal splitter.
[2] Includes iso-normal splitters and C_5-C_6 splitter.
[3] Utility costs used: Fuel, $2.10/Bbl (FOE); Steam, $0.60/1000 lb.; Water, $0.02/1000 gal.; and Electricity, $0.01/KWH.



Liquid-Phase Isomerization — SHELL DEVELOPMENT COMPANY

Application: For the isomerization of butane and pentane.

Description: The normal liquid paraffin (butane or pentane) is charged continuously at essentially atmospheric temperature through one of two feed dryers (used alternately and regenerated periodically), through a heater, thence through a catalyst-scrubber column and into the reactor. A liquid-liquid extraction of a small sidestream of the contactor catalyst with the feed takes place in the scrubber. The valuable active catalyst components pass back to the contactor in solution while the fluid inactive $AlCl_3$-hydrocarbon complex which forms as a consequence of the small amount of side reactions and the presence of feed impurities, runs to the bottom of the column and is periodically drained off.

The butane with dissolved recycle HCl is then contacted in the reactor with a solution of $AlCl_3$ in molten $SbCl_3$. A relatively short residence time in the reactor is sufficient to achieve a high conversion—55 to 60 percent for butane and 70-75 percent for pentane. After phase separation from the catalyst in an upper settling section of the reactor, the isomerizate flows to the catalyst-removal column for separation of dissolved catalyst by a simple fractionation. The recovered catalyst is pumped back to the reactor; the isomerizate is taken overhead, condensed, and pumped to the HCl stripper where the acid gas is removed and recycled to the reactor. The isomerizate, thus essentially freed of HCl, is given a caustic wash and sent to subsequent operations.

When isomerizing n-pentane, the reaction is effected in the presence of a small amount of hydrogen to suppress disproportionation reactions. The bulk of the hydrogen is recycled from the catalyst column accumulator; however, some passes in solution to the HCl stripper and is recycled with the HCl.

The small amount of uncondensable gas that is formed is vented from the accumulator through a scrubber.

Operating Conditions: See Table 1.

Yields: See Tables 2 and 3.

Commercial Installations: Five plants operating.

Reference: PETROLEUM REFINER 36, No. 9, 223 (1957).

TABLE 1—Design Conditions

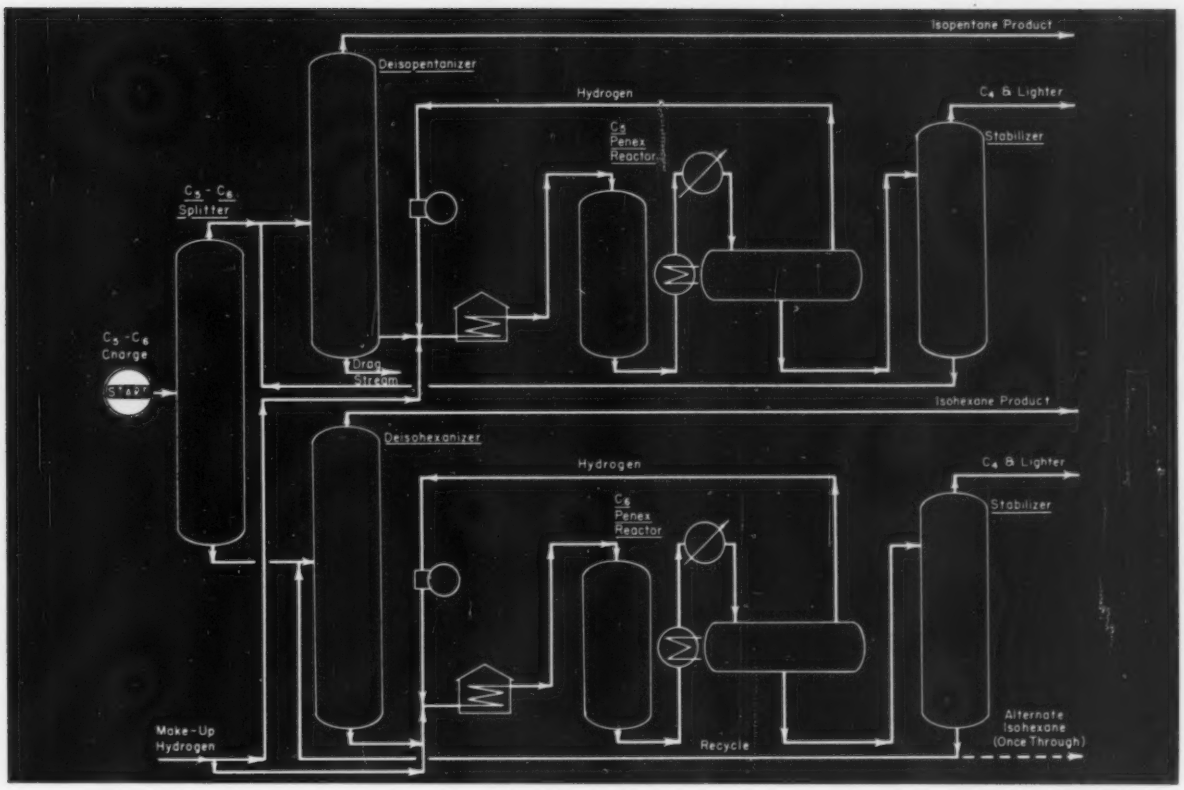
Process Conditions	Butane	Pentane
$AlCl_3$ content of catalyst, wt. %	9–10	3
Temperature in contactor, °F	176–194	176–212
HCl content of feed, weight percent	5	5
Operating Pressure, contactor, psig	300	300
H_2 partial pressure in contactor	...	60 psi. minimum
H_2 concentration in feed, mole %	...	1.3

TABLE 2—Yield Data for Butane

Component	Volume Units	
	Feed Stock	Single Pass Isomerizate
Ethane and lighter	...	0.1
Propane	...	1.6
Isobutane	4.0	61.0
Normal butane	95.0	36.4
Isopentane and heavier	1.0	3.0
Hydrocarbons as $AlCl_3$ complex	...	<0.1

TABLE 3—Yield Data for Pentane

Component	Volume Units	
	Feed Stock	Single Pass Isomerizate
Propane and lighter	...	0.1
Butanes	...	0.9
Isopentane	6.0	72.2
Normal pentane	92.0	24.5
Heavier than normal pentane	2.0	3.0
Hydrocarbon as $AlCl_3$ complex	...	<0.1



Penex — UNIVERSAL OIL PRODUCTS COMPANY

Application: Improves the octane rating of pentane and/or hexane fractions from refinery naphthas and natural gasolines by isomerization over a specially prepared platinum-containing catalyst in the presence of hydrogen.

Charge: Pentanes, hexanes or a C_5-C_6 mixture. Ideally, a C_5 fraction is fed to pentane isomerization, and C_5 isomers are fed to hexane isomerization, but processing a mixed C_5-C_6 stream in a single reactor also is feasible.

Description: A typical simplified flow diagram for Penex isomerization of a C_5-C_6 mixture is shown which employs a splitter to achieve close separation between pentanes and hexanes. Hexane isomerization in this example illustrates the alternatives of once-through or recycle processing—the exact arrangements are chosen to best suit the needs of the individual refinery; pentane isomerization illustrates recycle processing only—the usual commercial application. Hydrogen is employed to minimize the formation of catalyst deposits and normally is recycled. Make-up requirements may be furnished from a Platforming unit or some other supply source.

Reaction conditions are considered mild in severity. Temperatures range from 500 to 900 F; pressures from 300 to 1000 psi. Hydrogen consumption is insignificant. In C_5 isomerization the hydrogen requirement is about 40 scf/b, of which 10 scf/b is chemical loss and the balance is dissolved in the separator liquid product; in C_6 isomerization, chemical and solution losses are about 25 scf/b each. Highest yields of iso-compounds are obtained when pentanes and hexanes are isomerized separately, and when recycling of unconverted hydrocarbons is practiced.

Catalyst regeneration is not necessary; its life is long. Carbon steel construction is permissible because both catalyst and reaction products are non-corrosive.

Yields: Conversions approaching equilibrium are achieved in a single pass and recycling permits the achievement of virtually complete conversion. Typical yields from a mixed C_5-C_6 feed are shown in Table 1.

Economics: See Table 2.

Reference: *The Oil and Gas Journal* 55, No. 20, 142 (1957).

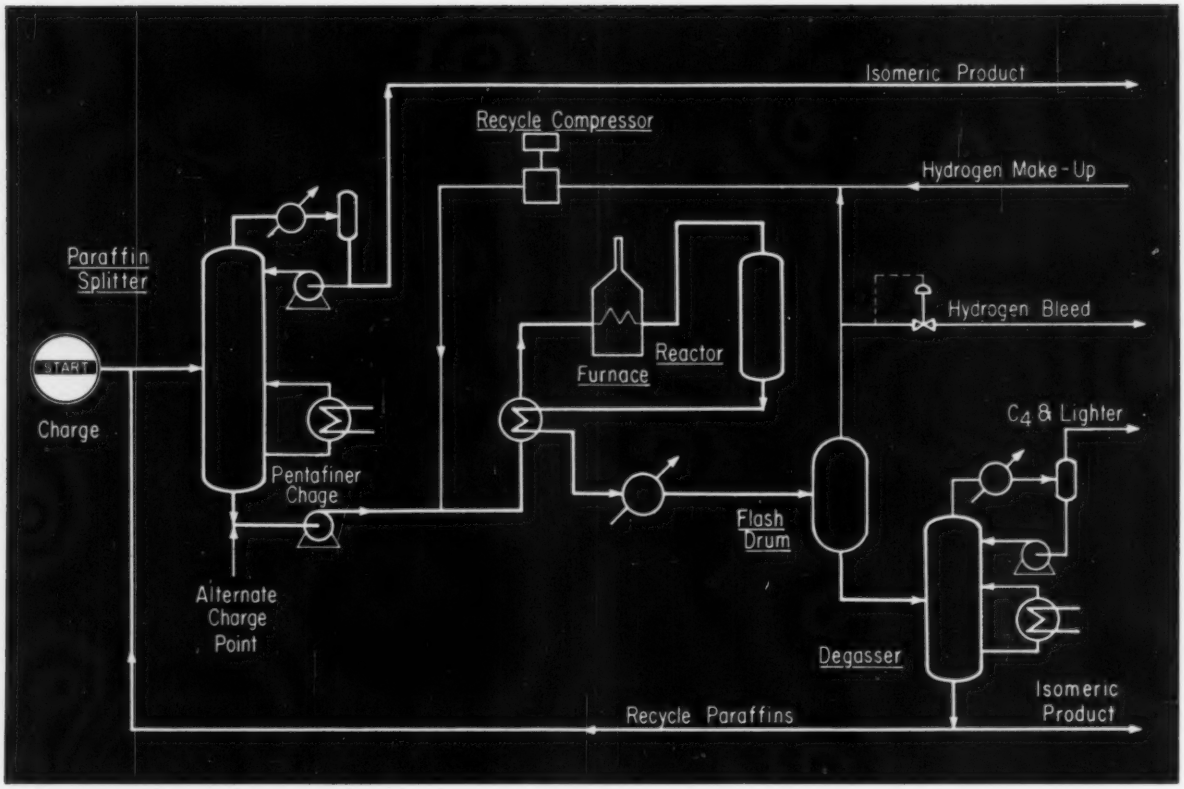
TABLE 1

	C_5-C_6 Feed	PENEX PRODUCTS	
		C_5 Product	C_6 Product
Yields, Vol. % reactor charge	....	99.0	98.2
Research Octane Number Clear	65.4	91.0	74.8
+ 3 ml. TEL/Gal	88.6	103.0	93.0

TABLE 2

	C_5-C_6 Splitter	C_5 Penex (Total Recycle)	C_5 Penex (Partial Recycle)
Fresh Feed, bpsd	6,464†	2,580	3,800
Isomerized Product, bpsd	.....	2,552	3,732
Unit Cost, Erected,* $	310,000	990,000	1,190,000
Operating Cost, ¢/Bbl:			
Labor and Supervision	.....	7.4	3.3
Utilities	.....	17.5	11.3
Maintenance, Taxes and Insurance	.....	6.2	4.8
Catalyst Replacement	.....	2.0	3.9
Total	.....	33.1	23.3

* Catalyst inventory excluded.
† Includes 84 bpsd withdrawn as dragstream.



Pentafining — THE ATLANTIC REFINING COMPANY

Application: Increases the octane rating of low-boiling normal paraffins by selective isomerization. The catalyst promotes chemical equilibrium with insignificant losses to butane and lighter.

Charge: Feed stocks should be rich in normal petane, hexane or heptane. All three may be isomerized together, but highest once-through conversions are obtained with a separate reaction section for each.

Product: The reaction product requires only degassing before inclusion in finished gasoline. No rerunning, sweetening, or other treatment is required.

Description: The flow diagram illustrates operation on a mixture of pentane, hexane, or heptane paraffins. The normal paraffin is first separated from its isomers in a conventional fractionating tower. The bottoms product, rich in normal paraffin, is charged to the Pentafiner.

The normal paraffin is mixed wih hydrogen recycle, preheated in exchange, and heated to reaction temperature in a furnace. The mixture is then passed downward through a single fixed bed of catalyst, wherein the temperature rises slightly. The reactor effluent is then cooled by exchange with the feed and condensed in a water cooler. The liquid separates from the recycle gas in a flash drum and then passes under level control to a simple degasser tower for removal of butanes and lighter. The gas from the flash drum is recycled.

After degassing, the equilibrium mixture may be recycled to the splitter for further separation of isoparaffins or taken directly to product gasoline blending. A small amount of hydrogen must be continuously added to hydrogenate the products of cracking and sustain pressure.

The catalyst is regenerated after long periods of operation with a dilute air mixture. Sulfur in the feed is handled by caustic washing to remove low-boiling mercaptans and hydrogen sulfide, or by a conventional amine scrubber on the recycle gas.

Operating Conditions: Reactor temperature is 800°-900° F, and operating pressure is in the range of 300 to 700 psig.

Yields: Typical once-through operations conducted just below equilibrium conditions give high yields of isomerized products with less than one percent of the feed being lost to butane and lighter. Ultimate yields of 95 percent iso-paraffins are 97-99 volume percent of the fresh charge to the splitter.

Economics: Pentafiner units are in effect simplified reformers with only a single reactor and are thus but a fraction of the cost of a similar capacity reformer. The fractionation of normal-paraffin rich Pentafiner feed is a difficult and costly operation such that distillation amounts to two-thirds and more of Pentafiner investment and operating costs. Economics for a specific unit depend heavily upon election of once-through or recycle isomerization as well as upon unit capacity.

Reference: PETROLEUM REFINER 36, No. 5, 172 (1957).

Polymerization

THE FUTURE FOR POLYMERIZATION is in fields other than motor fuel production. For the past several years the octane level of domestic gasoline has been too high to warrant the construction of polymerization units to meet this demand. The process, however, is still finding limited acceptance in countries where gasoline octanes are lagging.

Petrochemicals will now be the big user of the polymerization technique. Polymerization will strive to keep pace with the continued growth in polyethylene and polypropylene demands. Furthermore, the process will furnish the high molecular weight olefins needed for raw materials in the production of alcohols, aldehydes, detergents, etc.

The polymerization process combines unsaturated materials to yield a product having a higher molecular weight than the feed. Thus, a gaseous hydrocarbon like propylene can be polymerized to form a material boiling in the gasoline range.

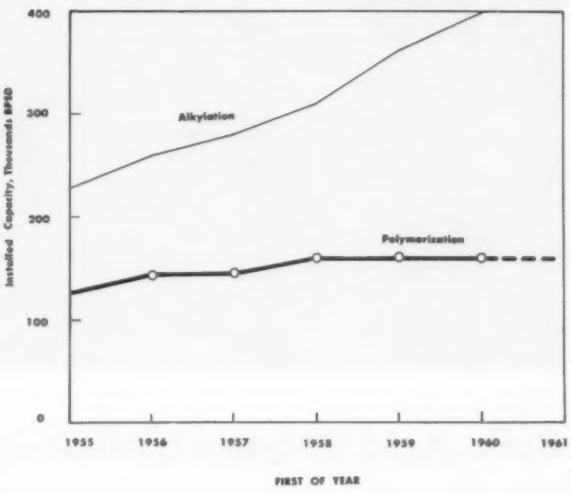
Alkylation competes with polymerization as an olefin consuming process. In the production of a motor fuel, alkylation usually wins over polymerization for the following reasons:

- Alkylation requires only one olefin molecule per molecule of produce, while polymerization requires at least two and usually more.
- Octanes from alkylation have a much higher Motor (F-2) rating than polymer gasoline. Thus alkylate furnishes a much superior gasoline blending component.

As for octanes, polymer gasoline has an F-1 rating of 95-97 unleaded and exhibits about the same lead susceptibility as catalytically cracked gasoline. Its sensitivity (12-14 octane numbers) is a little greater than cracked stocks. Thus its low Motor (F-2) rating is of little help to a refiner trying to compete with the present high octane gasoline market.

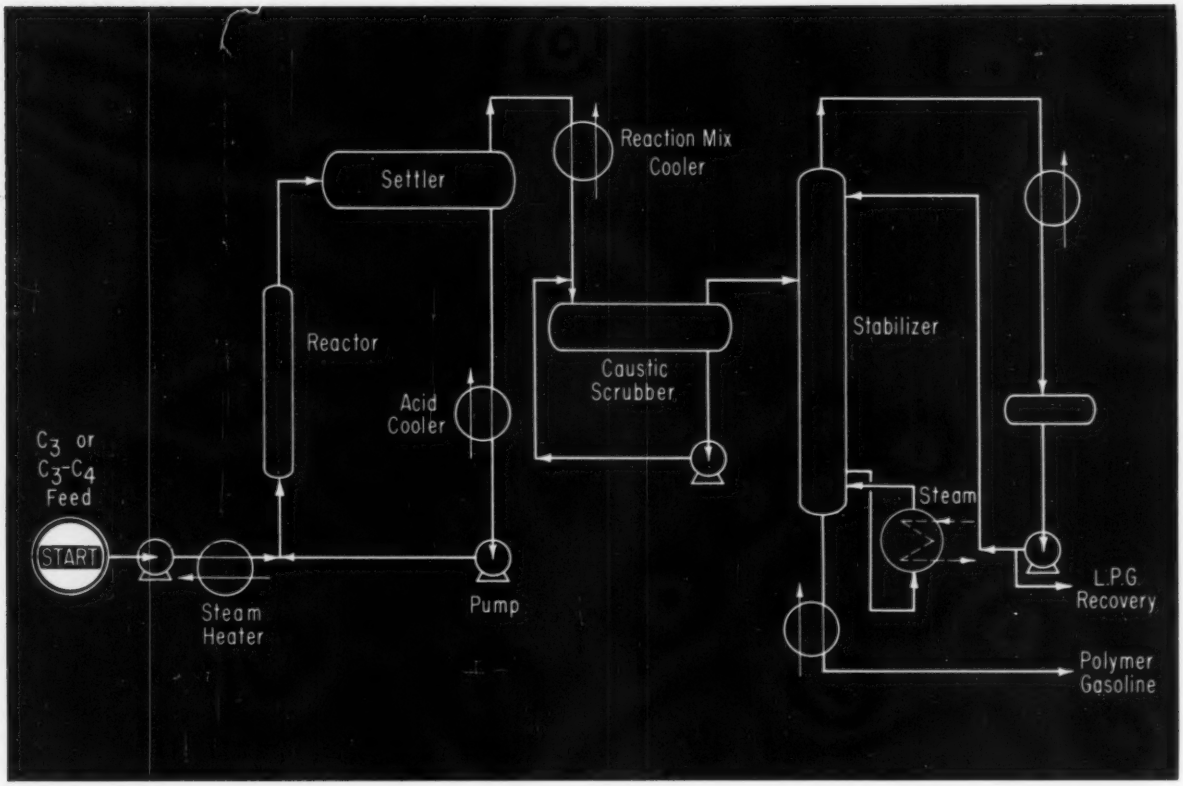
Polymerization is not strictly an octane improving process, since it makes gasoline blending components from materials which are not originally in the gasoline boiling range. Thus the process can contribute to the over-all economy of a refinery.

Most other processes which are used in the refinery make large quantities of gas. This is especially true since the shift from thermal cracking to catalytic cracking. Likewise, reforming furnishes byproduct gases by breaking down some of its naphtha charge. Any process, then, which can recombine these gases is of value to the refiner.



Latest development in the field of polymerization is the use of unsupported liquid phosphoric acid as a catalyst. The use of unsupported acid has been made possible by developments in materials of construction. Before equipment was economically available which could withstand liquid phosphoric acid corrosion at the required temperature and acid strength, units using phosphoric acid combined the acid with inert materials to form fixed beds of catalyst. Advantages claimed for the new techniques are better temperature control, high feed conversion, simplified product recovery, and high operating factors because the spent catalyst can be replaced without plant shutdown.

A comparison between the capacity of polymerization and the capacity of alkylation in the U.S. is shown in the accompanying graph. Polymerization capacity has held almost constant at about 150,000 barrels of product per stream day. Very little additional polymerization capacity is expected to be installed within the U.S. for the future, the process having given way completely to alkylation for motor fuel production.



Bulk Acid Polymerization — CALIFORNIA RESEARCH CORPORATION

Application: To produce high octane polymer gasoline from olefins.

Charge: All types of olefin feeds, with olefin concentrations as high as 95 percent. The feed must be caustic and water washed to remove sulfur and nitrogen compounds.

Liquid phosphoric acid, commercially available from a number of suppliers in this country and abroad, is the catalyst. No support material is required.

Product: The polymer product has an F-1 clear rating of from 93 to 99. Inspections on a typical mixed propylene-butylene polymer are shown below.

Gravity, ° API	59.5
ASTM Distillation, ° F.	
IBP	132
10%	206
50%	271
90%	372
EP	439
Octane Number	
F-1 Clear	96.8
F-1 + 3 ml. TEL	101
F-2 Clear	82.5
F-2 + 3 ml. TEL	86.0

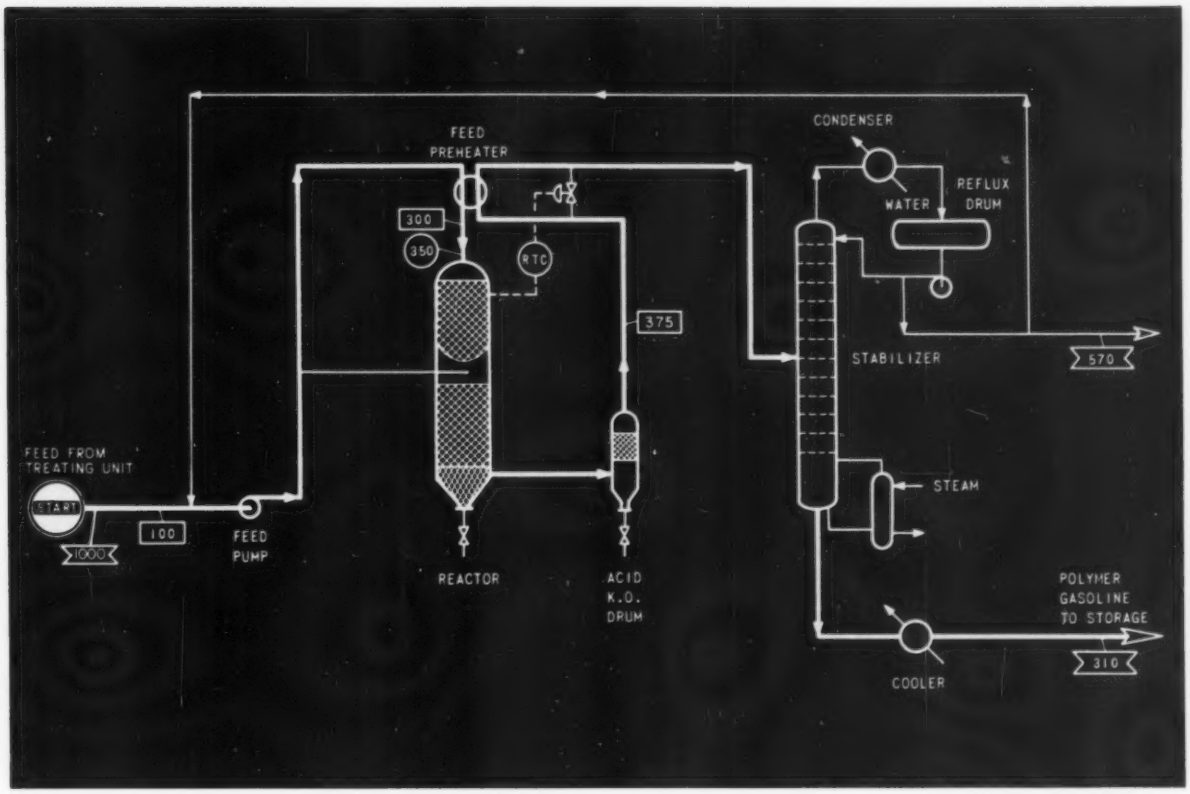
Gasoline polymer added to today's typical premium and regular gasolines maintains or improves road octane rating. For example, 20 percent gasoline polymer added to a 101.5 octane olefin aromatic base stock maintains the road octane. Similarly, 20 percent of the polymer added to a 98 F-1 paraffin aromatic base gasoline raises the road octane by 0.5 octane.

Description: The hydrocarbon feed and liquid phosphoric acid catalyst is brought into intimate contact in a small, high efficiency reactor. The reactor effluent is separated into acid and hydrocarbon in a conventional settler vessel, and the acid is returned to the reactor through a cooler. The product stream goes to recovery to yield polymer gasoline of the desired vapor pressure. Caustic scrubbing of the hydrocarbon from the settler is provided as protection for the recovery equipment from possible trace quantities of acid carryover. Caustic consumption is negligible. The acid stream which is returned from the settler to the reactor provides a high heat capacity "flywheel," so that temperature rise in the reactor is relatively small. Reactor temperatures can readily be controlled within narrow limits.

The small size of the reactor and the use of an all-liquid catalyst, without the requirement for loading and unloading solid catalyst support materials, means savings in site costs and in the plant. The process is characterized by a high operating factor and ease of maintaining high conversion of the order of 95-98 percent, with excellent temperature control without recycle. Investment costs in the recovery section are lower because of the lack of recycle requirement. Catalyst activity can be maintained by continuous addition of fresh acid and withdrawal of spent acid.

Commercial Installation: A 100-bpd plant has been operating in Richmond, Calif.

Reference: Petroleum Refiner 37, No. 5, 173 (1958).



California Polymerization — CALIFORNIA RESEARCH CORPORATION AND HYDROCARBON RESEARCH, INCORPORATED

Application: (1) To produce high octane polymer gasoline from olefins, or (2) to produce cumene from benzene and propylene.

Charge: The motor polymer process is equally applicable to total gas feed such as is obtained from cracking or reforming plants, or to a liquid stream containing propene or butenes, or mixtures of both. The feed is caustic washed for the removal of H_2S and mercaptans and water washed for removal of nitrogen compounds.

Product: The F-1 clear octane rating of the polymers is in the range of 93 to 99, the F-2 clear in the range of 80 to 85, and blending values are over 100.

Description: In the reaction section, part of the fresh feed, either liquid or vapor, is preheated to about 300° F by exchange with reaction mix coming from the reactor and is introduced into the top of the reactor. Polymerization of olefins is highly exothermic; and the temperature is limited to a maximum of 375° F by the introduction of the balance of the cold feed through quench points appropriately located in the reactor. Reaction mix from the bottom of the reactor flows through a small vessel packed with limestone for removal of traces of acid, exchanges with the top reactor feed, then flows to the product recovery section.

To prepare the catalyst, fine mesh quartz is supported on larger size quartz in the reactor. The reactor is filled with phosphoric acid and the excess drained off. A thin film of phosphoric acid remains on the quartz surface. To regenerate, the reactor is washed with water, steamed, and dried. After filling with phosphoric acid and draining off the excess acid, the reactor is then ready to go back on stream. This procedure can be completed in about 30 hours. In liquid feed operations, a catalyst life of at least 100 gallons of polymer per pound of phosphoric acid is obtained.

Operating Conditions: The motor polymer process is carried out between 300° F and 375° F, and at pressures from 150 to 600 psig. When the feed contains very high concentrations of olefins, a diluent (usually stabilizer overhead liquid) is added to absorb the heat of reaction.

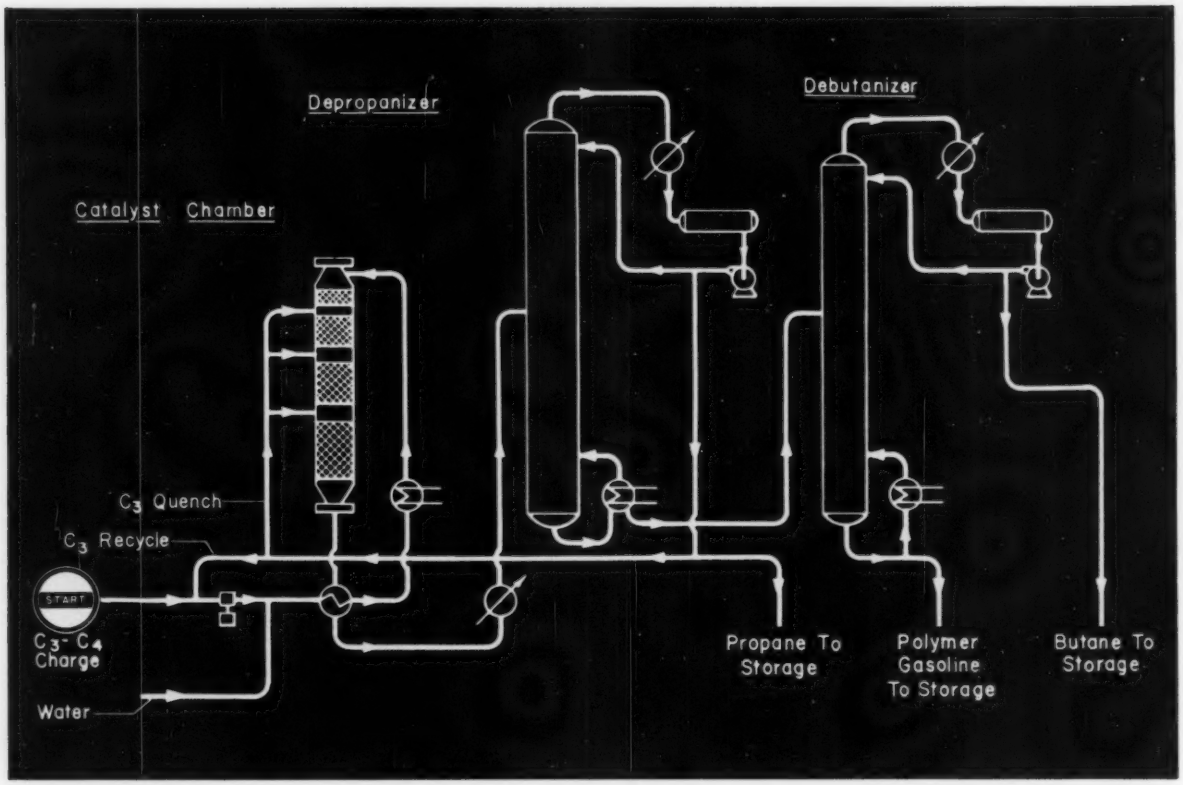
Yields: Conversions of 90 to 95 percent of the olefins are obtained. The table shows typical product properties:

	Propene[1] Polymer	Butene[2] Polymer
Gravity, °API	56.9	59.7
Reid Vapor Pressure, psi	0.5	2.0
Octane Number:		
F-1 Clear	93	99.0
F-1 + 3 ml TEL	99	102.3
F-2 Clear	80.5	81.0
F-2 + 3 ml TEL	85.0	84.2
ASTM Distillation, F:		
IBP	222	140
10 Percent	267	211
50 Percent	311	242
90 Percent	381	361
End Point	408	443

[1] Debutanized and rerun (95 percent rerun yield).
[2] Debutanized.

Commercial Installations: The first unit was built in 1937. There are now many plants in operation throughout the world.

Reference: PETROLEUM REFINER 31, No. 8, 79 (1952).



Solid Phosphoric Acid Condensation — UNIVERSAL OIL PRODUCTS COMPANY

Application: For converting propylene and butylenes to high octane gasoline blending agents; to polymerize pure propylene, or butylenes, into valuable chemical polymers; and to alkylate olefins with aromatic hydrocarbons.

Products: A full boiling range polymer from propylene or from a refinery mixture of propylene and butylenes; propylene dimer, trimer, tetramer and pentamer from propylene; cumene from alkylating benzene with propylene, and ethylbenzene from alkylating benzene with ethylene. The products are not limited to these compounds, however.

Description: The olefin-containing feed stream is brought into contact with the catalyst, when polymerization reactions are desired, at 350° to 435° F. and 400 to 1,200 psig. Alkylation conditions are 400° to 600° F. and 400 to 900 psig.

The catalyst is UOP Solid Phosphoric Acid, a pelletized and calcined mixture of phosphoric acid with kieselguhr. The reaction is exothermic but adiabatic conditions must be maintained for optimum yields of desired products and good catalyst life.

Two types of reactors are in use: (1) the tubular type in which the catalyst is packed into tubes surrounded by water jackets for temperature control, and (2) the more commonly used chamber type wherein the catalyst is divided into beds, between which a quench of cold reactor effluent is used to help maintain temperature, while a recycle of essentially paraffinic hydrocarbons is injected into the feed as a diluent for the same purpose.

The flowsheet shows the equipment arrangement for polymerization of propylene-butylene mixtures to produce motor polymers. When charging propane-propylene to make a motor polymer the debutanizer is not required. The synthesis of dimer (C_6 olefins), trimer (C_9 olefins), tetramer (C_{12} olefins) requires slight operation modifications and a re-run column.

Yields: Motor polymer made from C_3-C_4 olefins normally corresponds to 90-97 wt.-% on charge. Propylene motor polymer yields vary from 1 to 25 liquid volume percent of total polymer in the production of tetramer. The cumene yield is approximately 96 vol.-% of the propylene-benzene feed.

PROPERTIES OF PRODUCTS

	C_3 Motor Polymer	C_3-C_4 Polymer	Tetramer	Cumene
RVP, Psi	4.4	9.2	0.0	0.0
Gravity, ° API	59.5	66.1	51.0	32.1
ASTM Engler Dist.:				**ASTM Aromatic Dist.**
Initial Boiling Point, ° F.	136	96	353	301
10 Percent	228	149	361	302
50 Percent	**276**	**228**	**371**	**303**
90 Percent	338	348	397	303
End Point	420	422	450	304
Research octane with 3 ml. TEL	99.5	100	....	....

Reference: Jones, E. K., "Polymerization of Olefins from Cracked Gases," *Advances in Catalysis*, vol. VIII, p. 219, Academic Press, Inc., New York (1956).

Solvent Refining

SOLVENT REFINING methods are used primarily to extract (and dewax) lube oil fractions and to prepare feed stocks for catalytic cracking. By this method, hydrocarbon mixtures are separated on the basis of their relative solubilities without regard to volatility or the possibility of thermal decomposition. The processes are physical in nature, the chemical character of the various hydrocarbons remaining unchanged. Advantage of solvent refining is that it avoids high temperatures that lead to thermal decomposition of the feed stock.

Treating With Hydrogen

HYDRODESULFURIZATION is fast becoming a major process for removing sulfur compounds and other objectionable materials from refinery streams. The hydrogen for the process is readily available as a by-product from the many gasoline reforming processes being installed. In some cases, refiners are finding it worthwhile to install separate plants which crack methane and other light materials to produce the hydrogen needed.

A comprehensive review of this type of treating is given in the article by Herbert Kay on "What Hydrogen Treating Can Do," PETROLEUM REFINER 35, No. 9, pp 306-318 (1956).

Other Treating Processes

TREATING PROCESSES are essential to petroleum refining, although they have an accessory relation to the basic scheme of converting crude oils to gasolines and fuels. Treating is used to make feed stocks suitable for processing to their best advantage, and it finishes products to meet quality standards. As quality requirements become more stringent, investment in equipment and efforts devoted to operating and maintaining such processes reach sizable proportions.

Crude desalting is a treating method employed at the very beginning of a crude processing scheme. The large majority of crudes are contaminated with salt water, either as an emulsion with the oil or in free form.

Caustic washing is a widely used means of treating gasoline products for removal of hydrogen sulfide and mercaptans. Several processes use additional compounds in the caustic solution to promote reaction of the solution with the mercaptans. Dualayer, Mercapsol, and Solutizer processes use acid oils and phenolic materials for this purpose. Unisol uses methanol to improve extraction.

Some processes are designed to handle those situations where the caustic or other treating solution is reluctant to separate from the product. These are Electrical Distillate Treating and Distillate Treating.

Gas treating may be practised with such processes as Girbitol or Glycol Amine Gas Treating. They are employed usually to remove sulfur from gases charged to polymerization units.

Solid adsorbents as well as liquid chemicals are used by the refiner to improve the quality of his product. Among the processes using adsorbents are Percolation Filtration, Continuous Contact Filtration, and Thermofor Continuous Percolation.

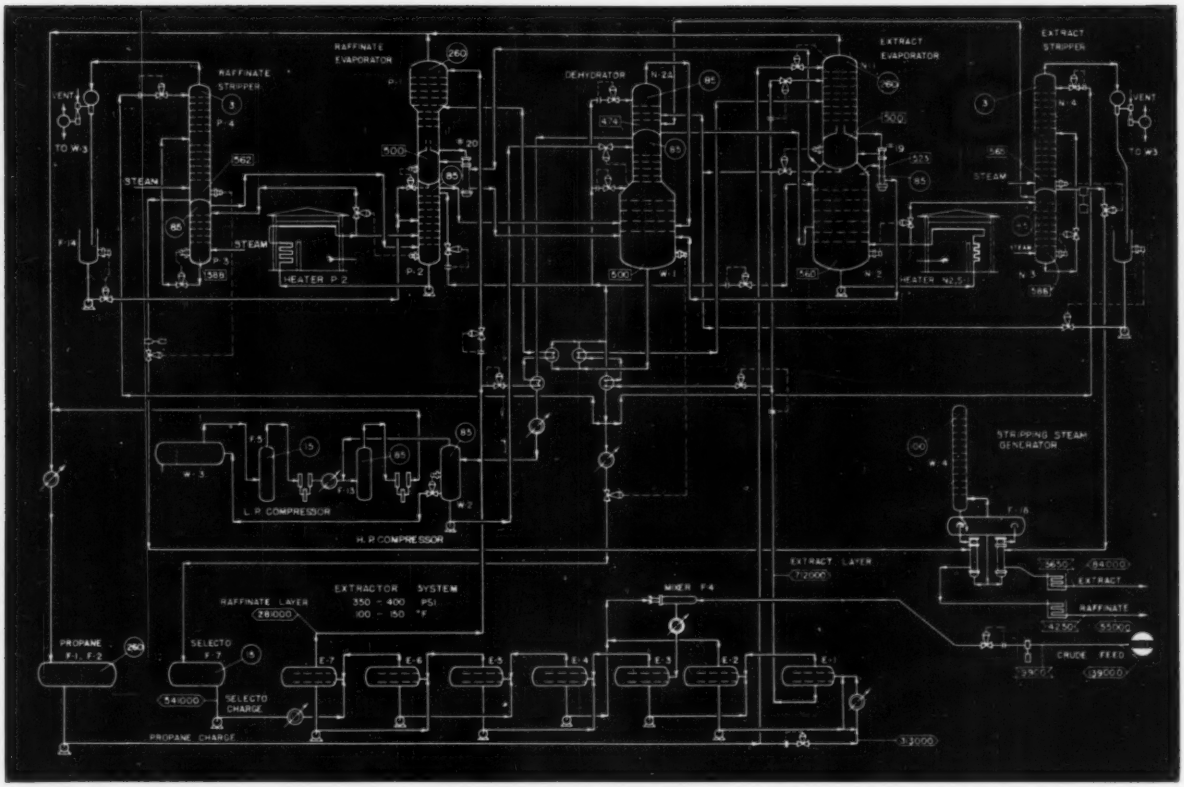
The latest addition to the treating section is the Merox process. Also this edition of the Handbook adds a description of inhibitor sweetening in order to give a comprehensive coverage of the treating processes available to the refiner.

Other Refining Processes

THERE ARE OTHER PROCESSES which do not logically fall into any of the previous catagories. Some of these are a very necessary part of a refining scheme. However, since there are many variations, only a few of these processes are represented here. They include the following:

- Crude distillation
- Light hydrocarbon recovery
- Separation by adsorbents
- Grease manufacturing

Two petrochemical processes are also included in this edition. The one for the production of butadiene is modified as it would be for the production of the butylene needed for alkylation feed. The hydrogen process is added because of its interest to refiners as a source of outside hydrogen for hydrodesulfurization. Other petrochemical processes may be reviewed by seeing PETROLEUM REFINER 38, No. 11, pp 183-306 (1959).



Duo-Sol — THE MILWHITE COMPANY, INCORPORATED

Application: For the extraction of high viscosity index, light color, low carbon residue lubricants from any residual or distillate base stock.

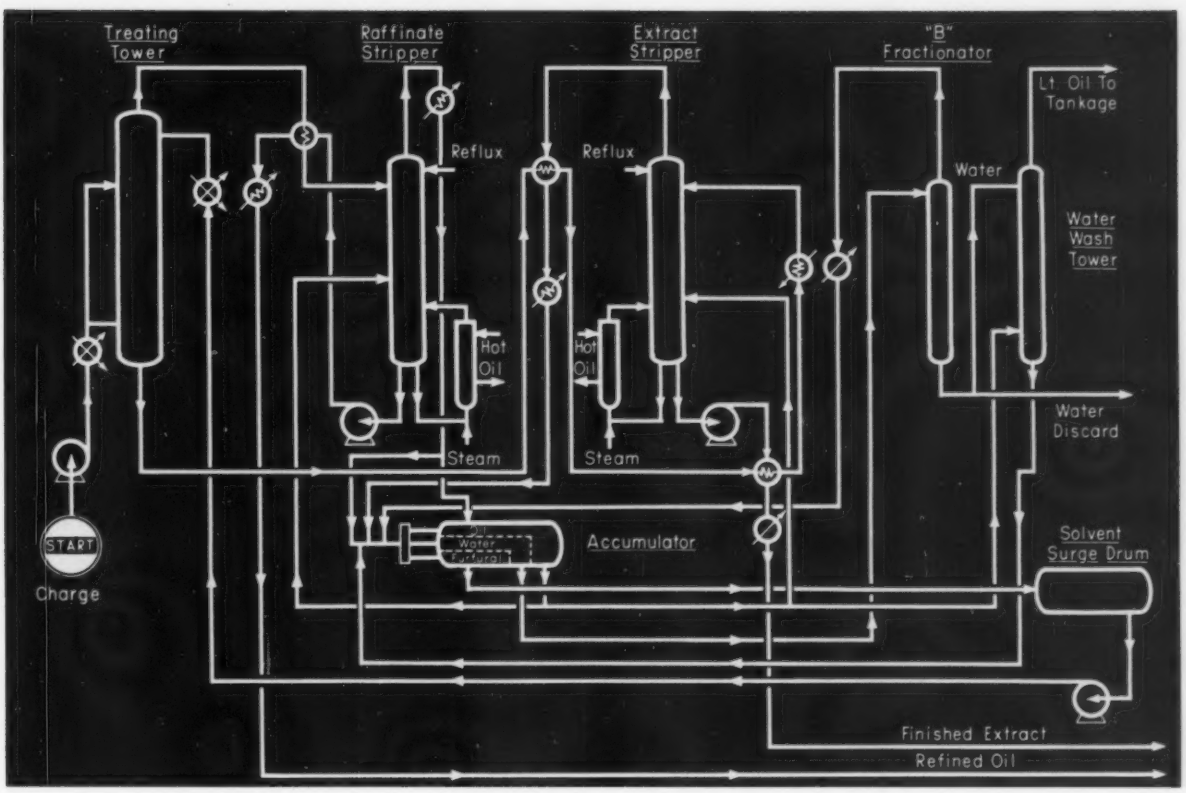
Description: The Duo-Sol process of solvent extraction is exclusive in its application of two solvents acting simultaneously and countercurrently on a charge stock introduced in the center of the extraction system. For maximum extraction efficiency, the countercurrent extraction is carried on in seven separate stages, identified as E-1 to E-7 on the flow diagram. The solvents employed, both of which are frequently refinery by-products, are propane which has affinity for raffinate and Selecto (a blend of cresol and phenol) which preferentially dissolves asphalts and undesirable aromatics, naphthenes and color bodies. In operation, the propane is charged into the E-1 end of the extraction system and Selecto into the E-7 end. In each extractor, the propane-raffinate leaves the top of the extractor vessel and passes to the next higher numbered stage, while the Selecto-extract is withdrawn from the bottom of each stage and pumped to the next lower numbered stage. Charge stock is generally admitted into E-3, together with raffinate phase from E-2 and extract phase from E-4. Raffinate progressing from E-3 to E-7 is treated in each stage with less diluted, more effective Selecto and extract from E-3 is stripped of all desirable constituents by propane in stages E-2 and E-1.

The solvents propane and Selecto are removed from the extract and raffinate layers by distillation in raffinate and extract evaporators P-1—P-2 and N-1—N-2, which consist of an upper section for higher pressure propane evaporation, and a lower section of the same vessel for evaporation of Selecto at low pressure. The final traces of Selecto are removed by a steam stripping in towers P-3, P-4, N-3, and N-4.

Yields: Typical extraction results are tabulated below:

	East Texas-Louisiana Residuum	San Joaquin Long Residuum	East Texas Distillate	Van Zandt Long Residuum	Iraq Long Residuum
Charge Stock:					
Gr. ASTM	15.2	14.9	26.2	17.4	14.8
Vis. @ 210° F. SUS	760	257	47.4	179	194
V.G.C.	.876	.893	.839	.879	.899
Flask °F.	595	470	420	435	420
Raffinate—Dewaxed:					
Gr. ASTM	26.5	29.3	29.9	27.5	27.6
Vis. at 210° F. SUS	143.3	61.0	48.0	64.4	54.2
V.G.C.	.809	.080	.811	.818	.822
V.I.	95	94	95	98	100
Pour	0	0	0	0	0
Color ASTM	8	4¼	2¾	5	3½
Conradson Carbon	.4	.1	.02	.25	.25
Duo-Sol Yield:					
Percent by Volume	43.6	34.7	73.0	60.9	55.0
Extract:					
Specific Gravity	1.026	1.0177	1.000	1.053	1.073

Commercial Installations: Nineteen.



Furfural Extraction of Gas Oils—TEXACO DEVELOPMENT CORPORATION

Application: For the solvent extraction of Diesel fuel oils, burning oils and cracking stocks to remove materials having low cetane number as well as such undesirable materials as unstable, acidic, sulfur, organo-metallic and nitrogen compounds.

Products: The resultant *raffinate oils* have a higher cetane number and show a marked degree of improvement in engine cleanliness, improved burning qualities and greatly reduced sulfur, nitrogen and metals content. The extract oils can normally be sold at a premium because of the high percentage of aromatics contained therein.

Description: This process for the extraction of gas oils is an outgrowth of the Furfural refining process which is widely used for refining lubricating oils.

The extraction temperatures and furfural treating ratios for gas oils are generally lower than when refining lubricating oil stocks. The principal difference between these two processes, however, lies in the equipment for the recovery of furfural from the raffinate and extract solutions.

Following an azeotropic distillation, solvent-free raffinate and extract streams are taken from the base of the respective strippers, while the overhead vapors from these columns comprising an azeotropic mixture of oil, water and furfural are condensed and conducted to an accumulator. Three liquid phases form in this decanting type of accumulator and all three of the components are present in each phase. The heaviest phase is predominantly furfural which is returned to the solvent circulating system. The intermediate phase is predominantly water. The lightest or oil-rich phase is pumped to a tower in which the furfural is extracted from the oil with water. The small percentage of light oil to be recovered in this way is dependent upon the initial boiling point of the gas oil charging stock.

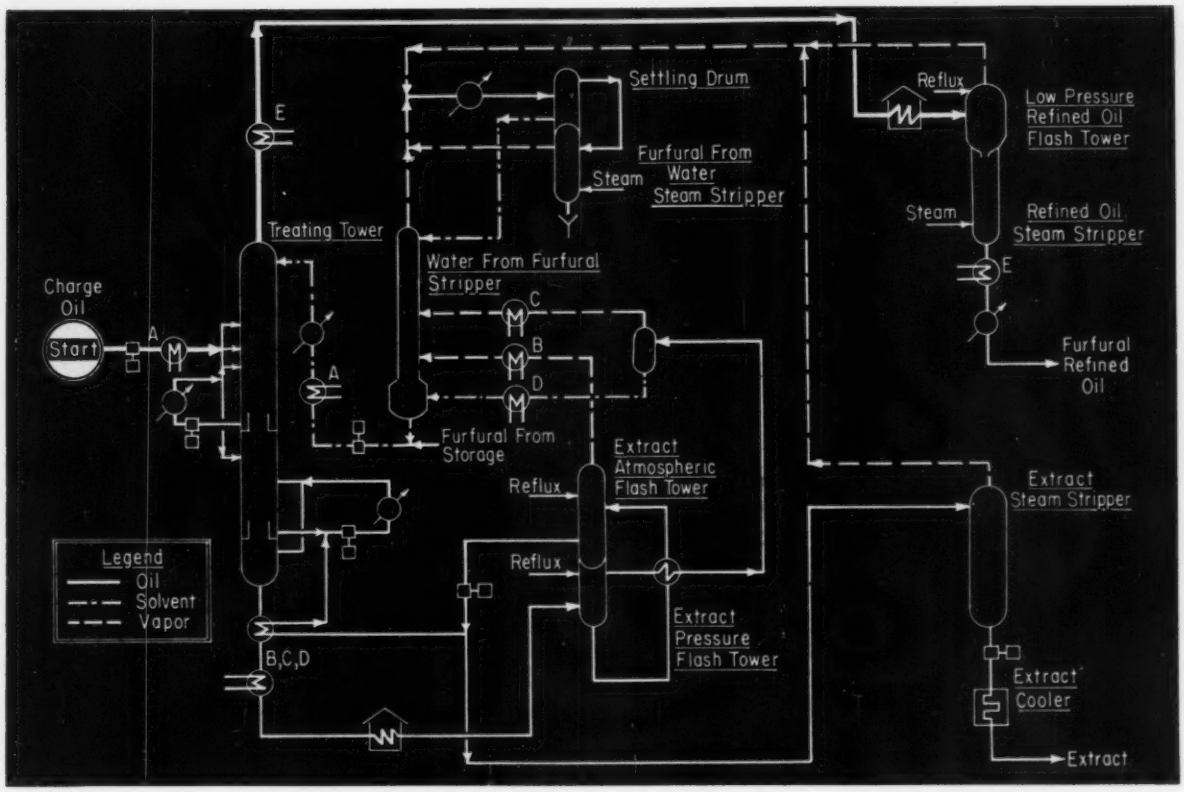
Adjustments can readily be made to permit the use of furfural containing a small percentage of oil and water.

This process is characterized by low solvent requirements which range from 25 percent of the charge oil when extracting a cycle gas oil stock for re-charging to a catalytic cracking unit to about 40 percent for a catalytic gas oil stock extracted for the production of high quality Diesel fuel or furnace oils and to about 80 percent when processing virgin gas oil stocks for the production of fuels, burning oils or cracking stocks.

Yields: The yield of product raffinate is dependent upon the nature of the charge stock and the degree of quality improvement desired. For example, when extracting a virgin gas oil derived from West Texas crude to a raffinate yield of 82 percent, the sulfur content was reduced from 1.12 to 0.49 percent, while the cetane number was increased from 53.2 to 62.9. Similarly, in the extraction of a catalytic cycle gas oil from Middle East crude oil, the sulfur content was reduced from 1.39 to 0.39 percent and the cetane number increased from 44.8 to 62.5 with a raffinate yield of 78.9 percent.

Commercial Installation: Eight.

Reference:: PETROLEUM REFINER 29, No. 9, 196 (1950).



Furfural Refining—TEXACO DEVELOPMENT CORPORATION

Application: To extract undesirable components from petroleum lubricating oil stocks in order to produce oils of high quality.

Product: The raffinate or refined oil product has greatly improved temperature viscosity characteristics and contains all the desirable lubricating oil components present in the charge stock.

Description: In operation, the untreated oil is introduced into a continuous counter-current extractor at some midpoint and at a predetermined temperature. The temperature of the furfural which enters near the top of the extractor depends largely upon the miscibility relationship between the furfural and the oil being refined. A substantial temperature gradient is maintained between the top and bottom of the tower by indirect, external water coolers. Extraction generally is accomplished by passing the furfural in dispersed phase downward over raschig ring nests through the prevailing oil phase.

The extraction efficiency can be maintained at a high level by the controlled recirculation of the material extracted. The recirculated extract serves to enrich the furfural phase with the more soluble material and thus to displace from solution the last remaining traces of cycle oil which joins the rising oil phase being refined.

The furfural refining unit represented in the accompanying flow diagram comprises an extraction or treating section, sections for the recovery of furfural from the refined oil and extract solutions respectively, water removal facilities, process surge tanks and pumping equipment. Because of its stability over a wide range of operating conditions, furfural lends itself to a variety of methods of recovery.

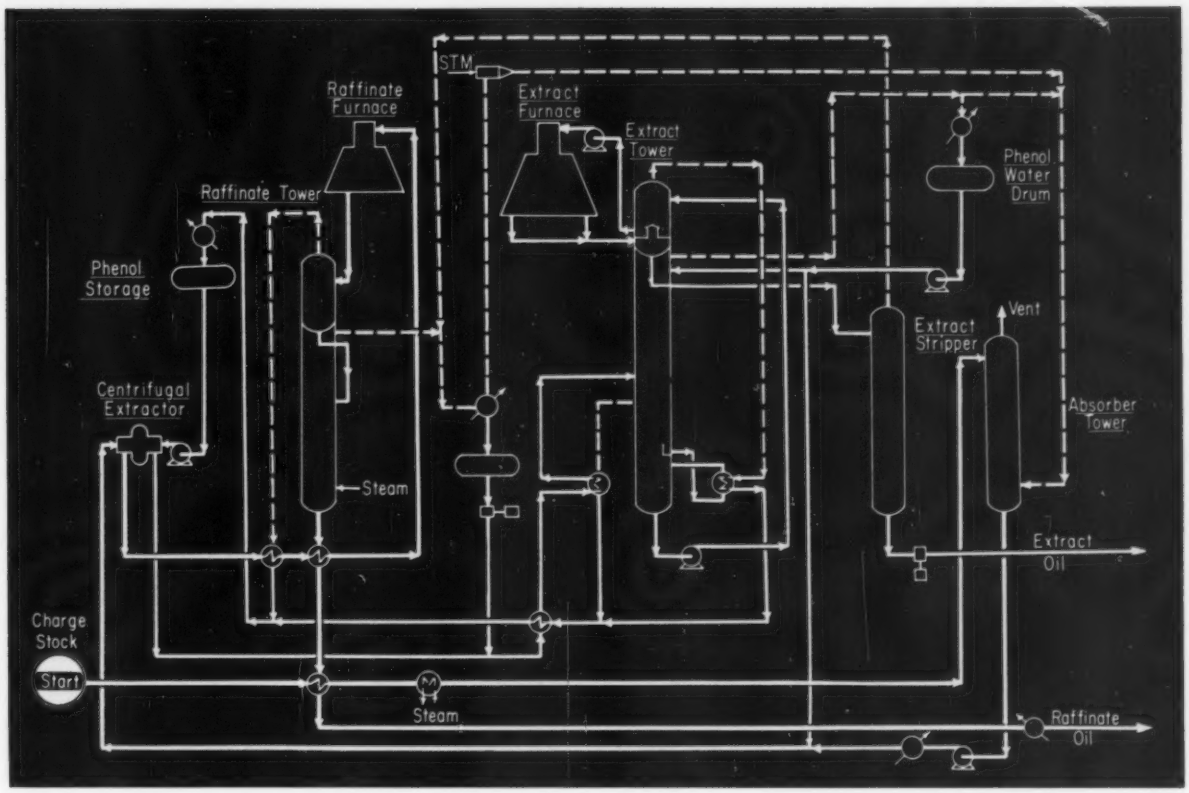
Furfural has a high solvent power for those components of petroleum which are relatively unstable to oxygen as well as other undesirable materials including color bodies, resins, carbon-forming constituents and sulfur compounds.

Yields: The operating conditions employed and the yields of raffinate obtained depend upon the nature of the charge stock and the degree of refining desired. Data of just a few of the many stocks typical of those processed for lubricating oil production are shown below:

Crude Source	East Texas	East Texas	Oklahoma City
Grade	Light Neutral Distillate	Deasphalted Bright Stock Residuum	Intermediate Viscosity Distillate
Charge Oil:			
Gravity, °API	28.3	23.1	25.4
Viscosity, SSU/210° F.	41.0	132.6	69.3
Carbon Residue, percent	0.07	1.40	0.52
Raffinate:			
Gravity, °API	32.5	29.6	30.9
Viscosity, SSU/210° F.	40.4	102.3	58.4
Carbon Residue, percent	0.01	0.20	0.03
Yield, percent by volume	85.0%	60.0%	76.9%
Dewaxed Raffinate:			
Gravity, °API	29.8	27.2	29.7
Viscosity, SSU/210° F.	43.0	140.6	63.2
Viscosity Index	96.0	94.1	96.0
Pour Point, °F.	20	0	0
Extract Gravity, °API	8.0	13.9	9.5

Commercial Installations: Fifty-seven units.

Reference: *Industrial and Engineering Chemistry* 40, No. 2, 220 (1948).



Phenol Extraction — THE M. W. KELLOGG COMPANY

Application: For improving viscosity index, color and oxidation resistance, and for reducing the carbon and sludge-forming tendencies of lubricating oils.

Charge: Raw lubricating oils of all viscosities, both distillates and bright stocks, from crudes of any type. Either waxy or dewaxed oils may be treated.

Product: Stable, light colored neutrals and bright stocks meeting the most rigid viscosity index specifications.

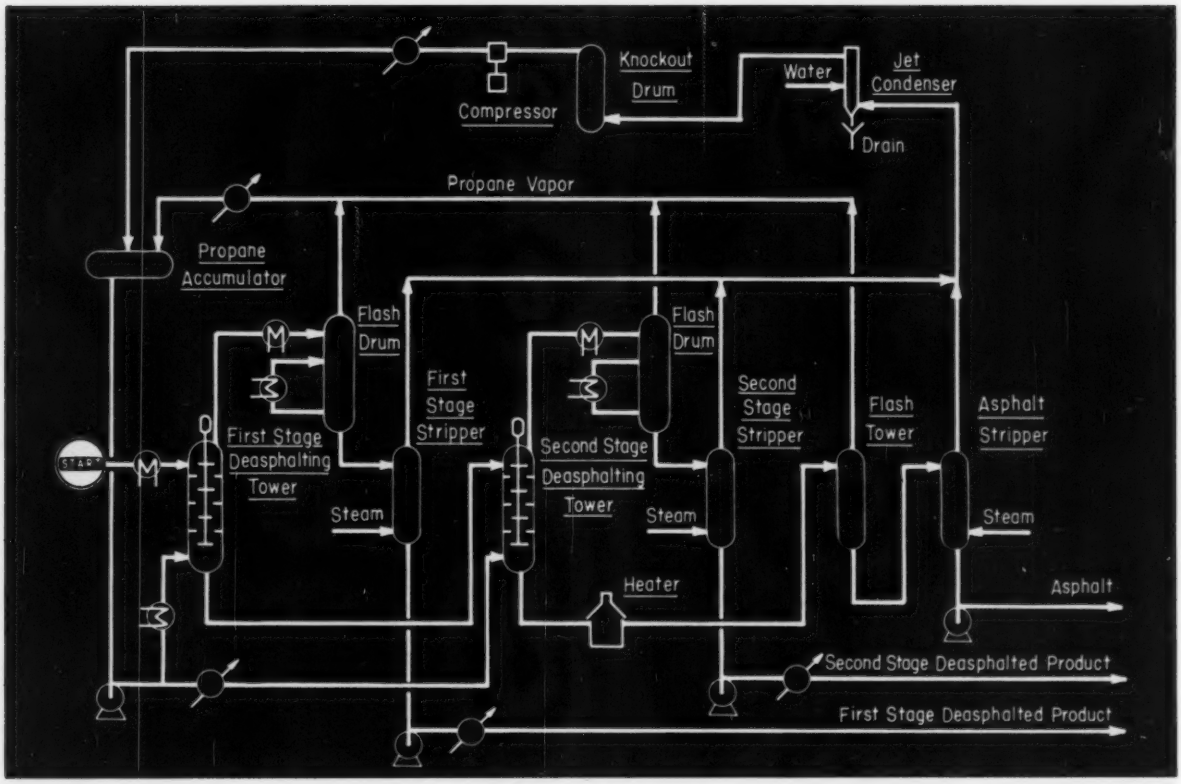
Description: Feed stock flows first through a phenol absorber tower to recover the small amount of phenol from steam being discharged from the plant. The feed is pumped from the absorber to the centrifugal extractor. Raffinate phase leaves the centrifugal extractor and, after heating, is flashed into the evaporator section of the raffinate tower. Phenol vapor from this section flows to a condenser and storage tank. The raffinate oil flows down to a section in which it is steam-stripped free of solvent and withdrawn as bottoms to storage. Steam and solvent vapors flow from the stripping section to vacuum equipment.

The extract phase from the centrifugal extractor is pumped through heat exchange to a drying tower, in which all water is removed as a phenol-water azeotrope. This vapor is condensed and enters the phenolic-water drum. Dry extract solution is pumped from the bottom of the phenol tower to a top evaporator section in which a portion of the phenol is flashed. The remaining extract solution is pumped from the evaporator section through a furnace coil. Extract oil flows from the evaporator section to a steam stripper, in which the last traces of solvent are removed, and then to storage.

Yields: The accompanying table illustrates typical yields and product inspection for several stocks.

	Deasphalted East Texas Residue	West Edmond SAE 40 Stock	Deasphalted Van Zandt Residue
Solvent/Oil Ratio Volume	3.0	2.13	3.48
Treating Temperature—F	245	201	200
Raffinate Yield—Volume Percent	64.5	88.2	59.3
Inspections-Untreated Oil:			
Gravity—°API	23.0	28.3	21.2
SSU Viscosity @ 210 F	159.0	77.4	180.1
Color ASTM	5	3	7
Carbon Residue, Conradson, Weight Percent	1.6	0.16	2.58
Dewaxed (Zero Pour) Viscosity Index	59	81	.....
Raffinate Inspections:			
Gravity—°API	29.0	30.2	27.3
SSU Viscosity @ 210 F	110.7	72.3	136.6
Color ASTM	4½	2—	6
Carbon Residue, Conradson, Weight Percent	0.26	0.04	.....
Dewaxed (Zero Pour) Viscosity Index	94	93	101.4

Commercial Installations: There are 24 units in operation.



Propane Deasphalting, Two Stage—FOSTER WHEELER CORPORATION

Application: For separation of asphalt and two grades of lubricating oils from heavy residues by controlled solvent extraction.

Description: The two-stage deasphalting process using rotating disc contactors is a relatively new development of propane deasphalting. The process separates the required lube fractions by their solubility in liquid propane, which differs from the method of separating according to volatility as in vacuum distillation.

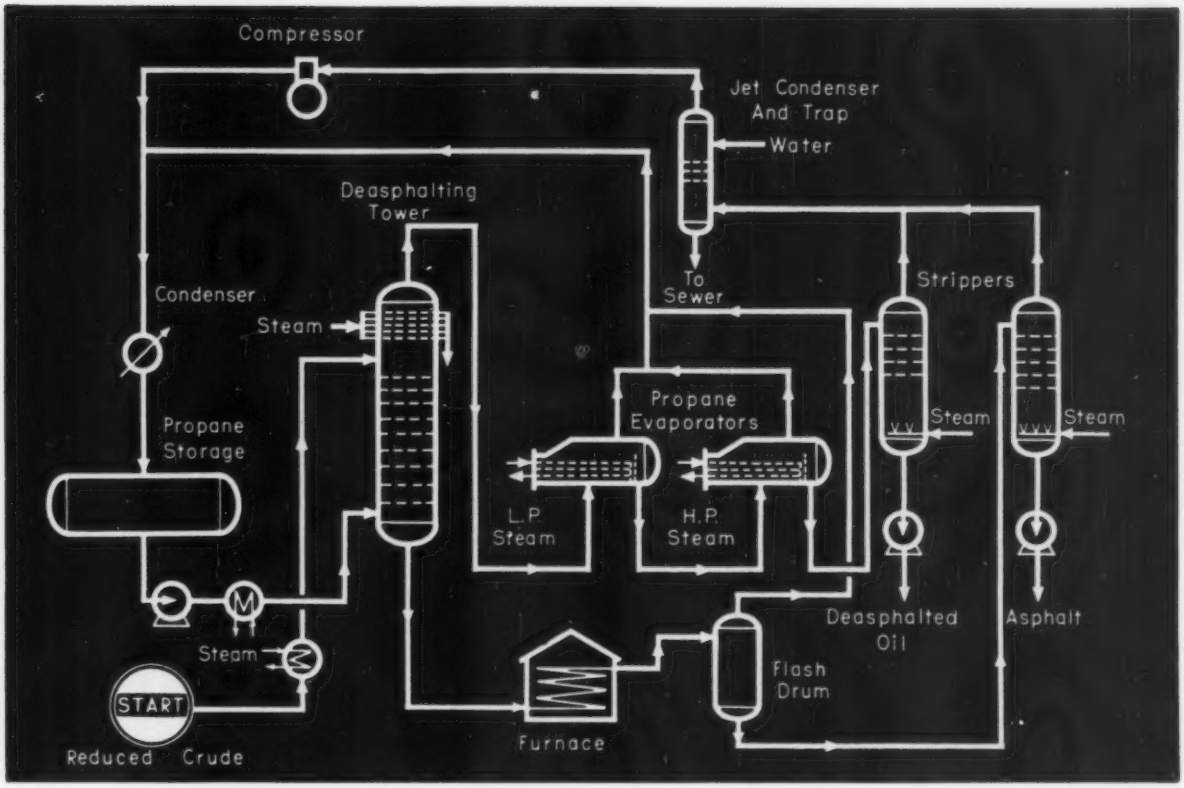
The selective properties of liquid propane can be altered by changing the operating conditions, i.e., temperature, pressure and solvent-to-oil ratio, to obtain the required lube-oil product. This process not only produces high yields of high viscosity index lube-oil fractions, but also operates at comparatively low temperatures. Thus, the process eliminates the thermal decomposition which might occur in distillation.

In accordance with the accompanying flow diagram, the bottoms from a vacuum distillation unit is the usual charge and is pumped into the upper part of the first-stage deasphalting tower. Liquid propane is pumped into the lower part of the tower. The countercurrent extraction ensuing in the rotating disc contactor provides an overhead fraction of the first-stage deasphalted oil (SAE-40 or SAE-50 oil) and propane. These flow to the first-stage oil recovery system. The bottom fraction from the first-stage contactor which flows under level control is oil, asphalt and propane. It constitutes the charge to the upper section of the second-stage deasphalting tower.

The second stage is operated at a lower temperature and pressure. Countercurrent extraction produces an overhead phase of second-stage deasphalted oil (cylinder oil) and propane which flows to the second-stage oil recovery system. The bottom phase of asphalt and propane passes under flow control from the contactor to the asphalt-mix heater and then to the asphalt recovery system. After the bulk of the propane is vaporized and separated, the remainder is removed from the asphalt by steam stripping.

Separate oil recovery systems are used for the two overhead oil-propane streams flowing from the tops of the extraction towers. Steam evaporators in combination with flash towers and steam strippers separate the product from the propane which is returned to the system.

Desired temperature gradients are maintained in the first-stage and second-stage towers by means of steam coils. Operating pressure is held on the towers by a back-pressure controller located in each of the two overhead lines. Since this pressure is greater than the vapor pressure of propane at the maximum tower operating temperature, the tower contents are prevented from vaporizing and remain in the liquid phase.



Propane Deasphalting and Fractionation—THE M. W. KELLOGG COMPANY

Application: For separating asphalts or resins from viscous petroleum fractions finished into cylinder stocks, bright stocks and aviation lubes. The process may be modified to segregate heavy or medium neutral fractions by extraction with liquid propane rather than by distillation.

Description: Feed is pumped to the deasphalting tower after its temperature is adjusted as required by heating or cooling. Liquid propane is introduced near the bottom of the tower and flows upward in a counter-current extraction. A temperature gradient at the top of the tower (via steam coils) induces reflux to maximize selectivity of the separation.

The tower overhead stream consists of deasphalted oil and propane. The bulk of the propane is removed in two stages of evaporation and traces are removed in the stream stripper.

The tower bottoms consist of asphalt and propane. The bulk of the propane is removed in the furnace followed by flash drum arrangement and the traces are removed in the stream stripper.

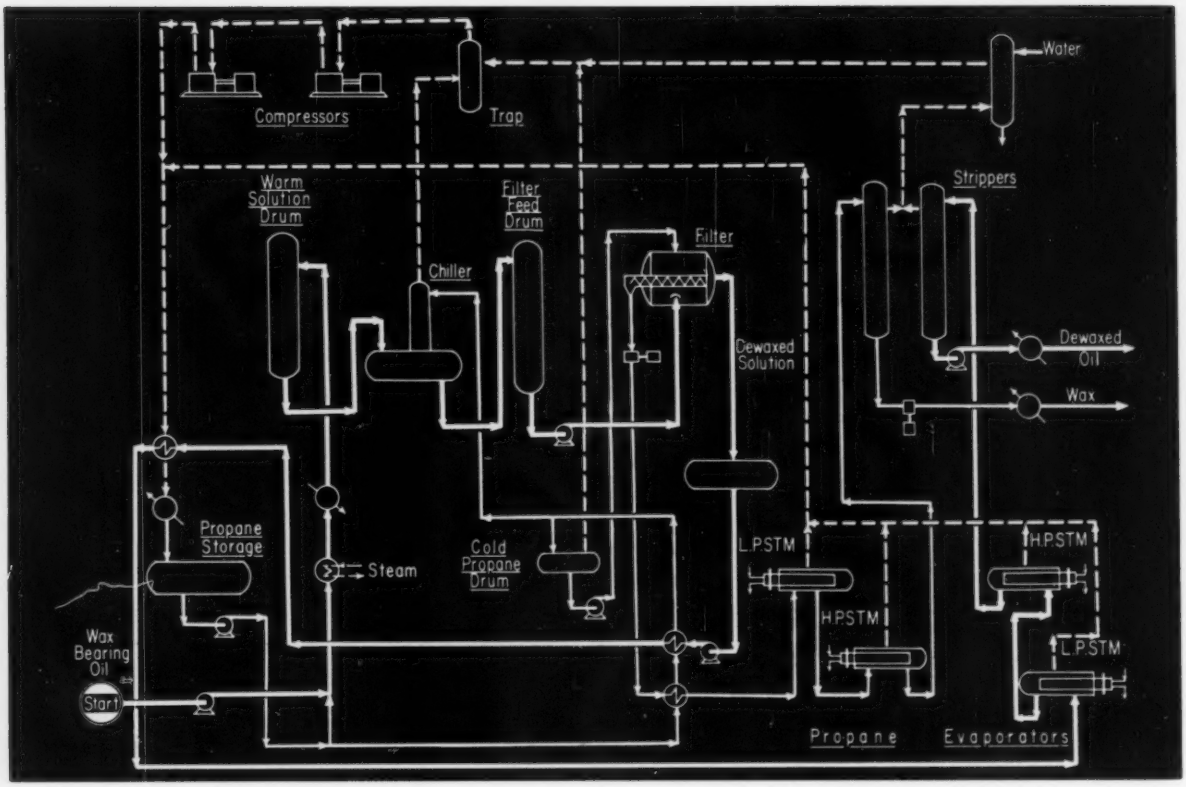
The flowsheet of a Propane Fractionation unit is similar to that shown above except that an additional extraction tower and an additional recovery system are added for each additional product.

Commercial Installations: There are 45 Propane Deasphalting units in operation. In addition there are three Propane Fractionation units producing two or more grades of lube stock and three which refractionate bottoms into two or more high-viscosity resins.

Yields: Typical yields for deasphalting and a comparison of distillation with Propane Fractionation follows:

	Oklahoma	Iraq	Le Duc	Illinois		Pennsylvania	West Edmond
Reduced Crude:							
Gravity—°API	19.3	7.1	12.1	13.7		25.1	19.3
SSU Vis. at 210 °F.	385	4888	2050	1760		220	514
Conradson Carbon, Weight Percent	7.3	19.7	17.1	13.4		2.76	5.9
Deasphalted Oil:							
Yield—Vol. Percent	75.6	34.1	47.1	44.3	50.7	83.7	39.4
Gravity—°API	23.6	20.2	22.7	24.2	23.4	26.6	24.7
SSU Vis. at 210° F.	141	179	199	158	190	144	155
Color ASTM	6	8	6—	5—	5—	4½—	4½—
Conradson Carbon, Weight Percent	1.48	2.36	1.7	1.2	1.4	1.1	0.97
Asphalt:						Resins	
Yield—Vol. Percent	24.4	65.9	52.9	55.7	49.3	16.3	60.6
Specific Gravity °API	1.0227	1.0639	1.0542	1.023	1.030	0.9529	15.8
Softening Point °F.	144	145	176	135	145	.....	.....
S.F. Viscosity at 210 °F.	.....	.....	.....	.....	.....	339	.....
Solvent/Oil Ratio—Volume	7.8	9.9	7.9	8	8	12.7	6

	Medium Neut.	Cylinder Stock	Residue
Vacuum Distillation:			
Yield Percent on Crude	13.0	.....	14.3
Position in Crude—Percent	72.7-85.7	Not Produced	85.7-100
Viscosity SSU at 210° F.	90.7	.....	6840
Gravity—°API	19.0	.....	7.3
Color—ASTM	5 (D)	.....	.....
Conradson Carbon—Weight Percent	2.1	.....	21.4
Dewaxed (0° F Pour Pt.) V.I.	50.2	.....	.....
Propane Fractionation:			
Yield Percent on Crude	8.6	3.2	11.5
Position in Crude—Percent	76.7-85.3	85.3-88.5	88.5-100
Viscosity SSU at 210° F.	94.0	239	.....
Gravity—°API	24.3	18.0	1.6
Color—ASTM	4½	5	.....
Conradson Carbon—Weight Percent	0.66	2.6	.....
Dewaxed (0° F Pour Pt.) V.I.	80.6	.....	.....
Softening Pt. (R & B) °F.	.....	.....	130



Propane Dewaxing — THE M. W. KELLOGG COMPANY

Application: Separates high pour point waxy materials from lubricating oils.

Charge: Waxy distillates and residuals ranging from diesel oil to highest viscosity grades of cylinder stock. Narrow-cut and very wide-cut fractions are dewaxed with equal success.

Product: Zero or lower pour test oils with exceptionally low cloud points and wax.

Description: Oil and propane are continuously charged through a heater which insures that all wax crystals are dissolved. The charge solution enters one of two parallel chillers in which its temperature is reduced at a controlled rate to filtering temperature by evaporation of propane. During chilling, wax crystals form and remain suspended in the propane-oil solution. The chilled slurry is charged to one or more continuous rotary filters via a filter feed tank. The wax cake on the filter is washed with cold propane to free it of oil, after which it is discharged to the wax recovery system. The filtrate, which comprises the wax-free oil together with most of the solvent and wash propane, is processed in a similar recovery system.

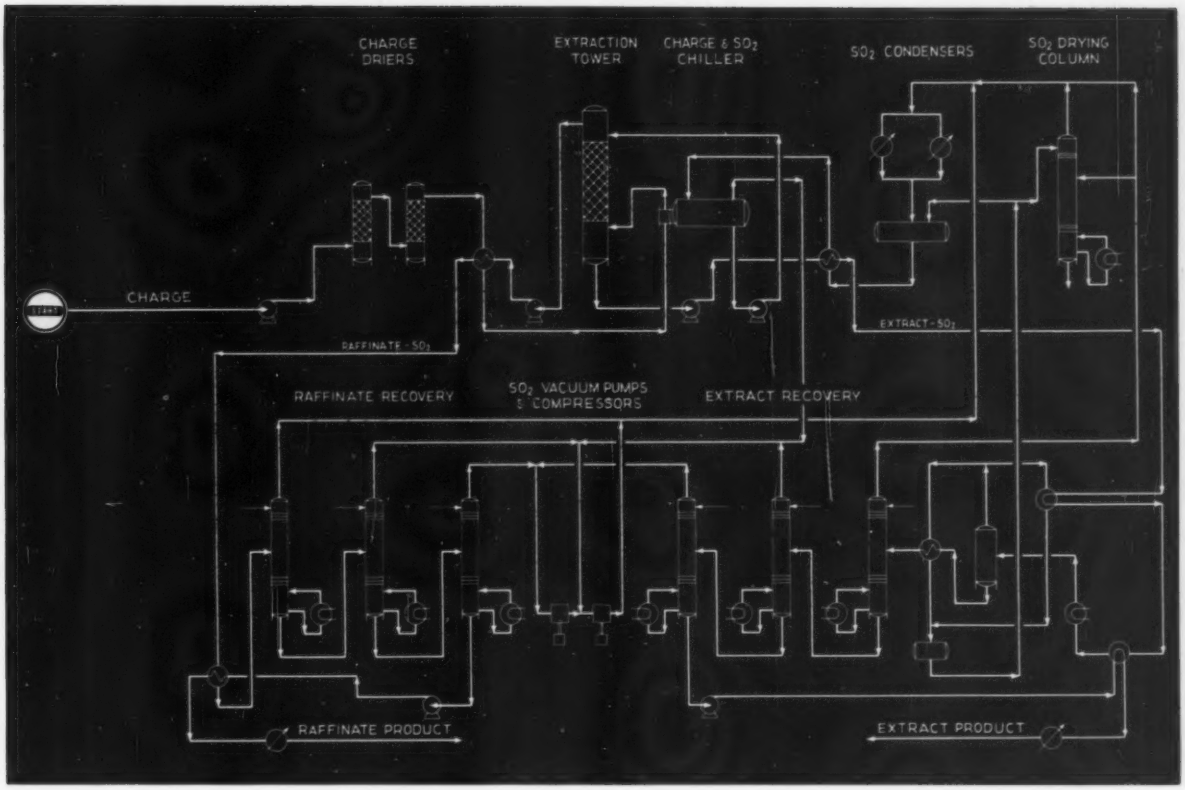
The product recovery systems comprise steam-heated evaporators operated under sufficient pressure that the vaporized propane can be condensed for re-use with plant cooling water, followed by direct steam strippers held at atmospheric pressure. Only the traces of propane removed in the strippers, plus that vaporized during the chilling operation, require compression.

The simplicity and economy of the process result largely from the fact that a single fluid—ordinary propane—serves as solvent, as diluent, as refrigerant and (in vapor form) as blanketing gas and filter blow-back. In dewaxing oils of varying viscosities, the only solvent adjustment required is the ratio of propane to oil.

Yields: The following table gives the yields and inspections on four lubricating stocks:

	Propane Deasphalted Phenol Treated 15 Percent E. Texas Reduced Crude	Phenol Treated E. Texas Heavy Distillate	Propane Deasphalted Phenol Treated W. Edmond SAE 70 Stock	Propane Deasphalted Phenol Treated Okla. City SAE 40 Stock
Propane, Volume Percent	300	250	300	300
Filtering Temp., F	—34	—35	—40	—41
Dewaxed Oil Volume Percent	61.6	67.7	85.5	81.1
Inspections Waxy Oil:				
°API Gravity	29.7	32.0	27.4	30.1
SSU Viscosity at 210 F	93.1	57.3	132	72.7
Color ASTM	4½—	2—	3½—	2—
Carbon Residue, Percent	0.20	.....	0.25	0.06
V.G.C.	.795	.790	.803	.797
Dewaxed Oil:				
°API Gravity	27.6	28.9	26.7	28.7
SSU Viscosity at 210 F	118.4	66.2	150.0	79.6
Color ASTM	4½—	2—	3½—	2—
Pour Point, F	0	0	0	—5
Carbon Residue, Percent	0.26	0.03	0.30	0.05
Viscosity Index	95	92.1	91.1	92.1
V.G.C.	.804	.808	.807	.804

Commercial Installations: There are 16 units in operation.



SO_2 Extraction — STONE & WEBSTER ENGINEERING CORPORATION

Application: To remove aromatic hydrocarbons and sulfur bearing compounds from paraffinic and naphthenic hydrocarbons to produce high quality raffinate products. The process also recovers high purity aromatics.

Charge: The fractions range in boiling point from naphtha and catalytic reformates through kerosine, gas oils, cycle oils and low and medium viscosity lubricating oils. Minor modifications in design permit blocked operation for a wide variety of charge stocks.

Product: The extraction of aromatic hydrocarbons serves two purposes; the remaining oil may be upgraded or the aromatic fraction may be the desired product.

Description: The accompanying diagram illustrates the flow in a plant designed for handling stocks ranging from light naphthas to light lube oil distillates.

The charge stock flows through a coalescer for the removal of free water and then is dried. The charge oil is next cooled by heat exchange with raffinate solution and further by refrigeration with SO_2. It is then introduced into the lower section of the packed extraction tower.

In the extraction tower, the charge oil is contacted with chilled liquid sulfur dioxide and is separated into a refined oil phase and an extract phase. The latter contains most of the SO_2 used for the extraction. The raffinate phase leaves the extraction tower at the top, while the extract phase accumulates in the base section. Both phases flow into their respective solvent recovery sections in which the SO_2 contained in the oil is removed in evaporators.

The process consumes about 0.15 pounds of sulfur dioxide per barrel of charge. This is due to leakage, venting of the condensers, and incomplete recovery from the products and from the water removed in the drying tower.

Operating Conditions: Reformates and kerosines are extracted at —20° F, with +60° F used for high pour point oils. The high selectivity of SO_2 permits using very low SO_2 treat, 0.62 to 1.65 vol. per vol. of charge at only 2-5 extraction stages.

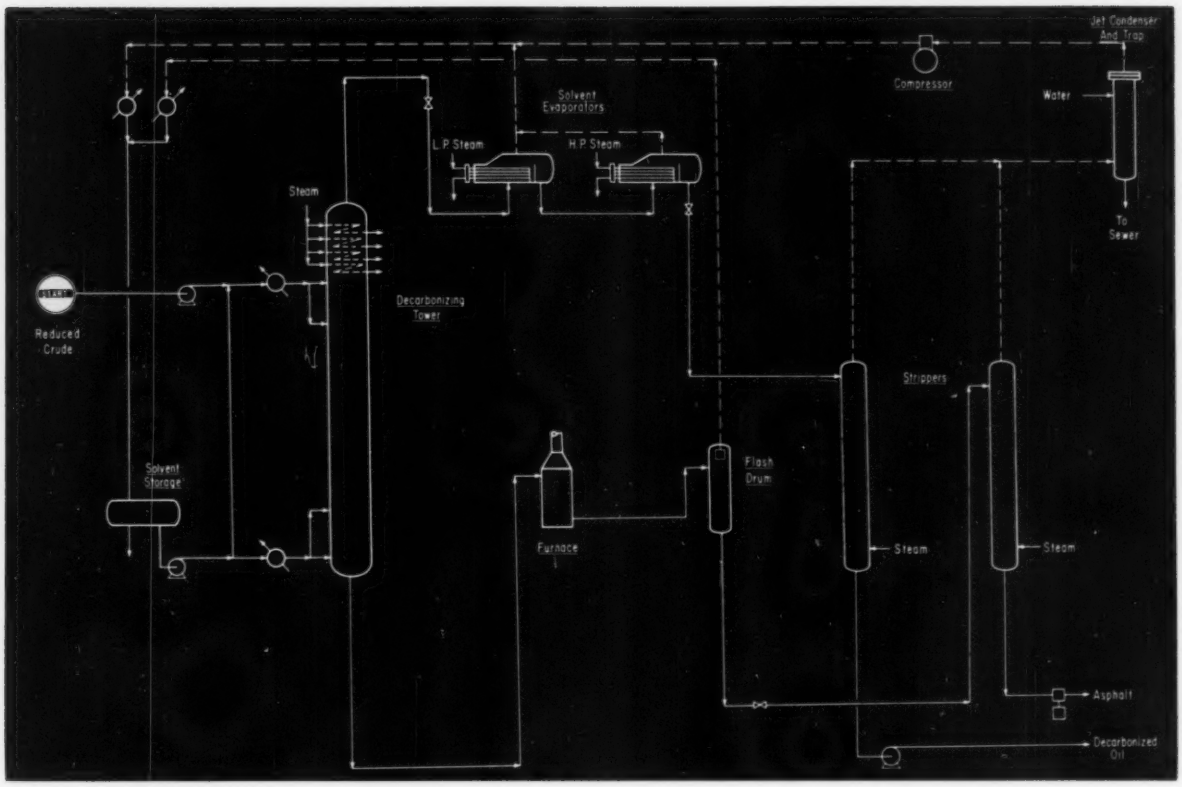
Yields: High purity benzene, toluene and xylenes are extracted from reformates with simultaneous individual aromatic recoveries greater than 97 percent.

Lamp oils are improved to a smoke point of 30-40 with removal of 75-90 percent of the original sulfur and 85-95 percent of the original aromatics present in the feed. Raffinate yields vary from 75-90 percent by volume referred to paraffins in feed.

Treatment of gas oils produces raffinates containing 5 percent or less of aromatics and extracts of an aromaticity of 70-80 percent. The process produces premium quality diesel fuels from straight run or cracked stocks. The treatment of catalytic cracking cycle stock reduces the coke laydown in subsequent cracking by 50 percent or more.

Commercial Installations: The total installed charge capacity of SO_2 extraction plants in the United States and foreign countries is about 200,000 bpd. Plants for a total charge capacity of 114,000 bpd have been built by Stone & Webster Engineering Corporation and its affiliates.

Reference: PETROLEUM REFINER 30, No. 9, 237 (1951).



Solvent Decarbonizing— THE M. W. KELLOGG COMPANY

Application: To recover paraffinic catalytic cracking stock from distillation residues, increasing yields of light products at the expense of fuel oil.

Charge: Atmospheric or Vacuum reduced crude.

Product: A premium catalytic cracking feedstock and a virgin asphalt which, if from suitable crude, may be blended to paving specifications.

Description: Solvent decarbonizing is a low-temperature extraction process. The feed is reduced in temperature by heat exchange and cooling and charged to the decarbonizing tower. Solvent, introduced near the bottom of the tower, is contacted counter-currently with the descending heavy oil. Steam coils near the top of the tower, by imposing a temperature gradient, provide reflux so as to maximize the selectivity of the separation.

The decarbonized oil solution withdrawn overhead is heated under pressure to evaporate solvent, most of the heat being obtained from exhaust steam. The last traces are removed by direct contact with steam at low pressure in the decarbonized oil stripper.

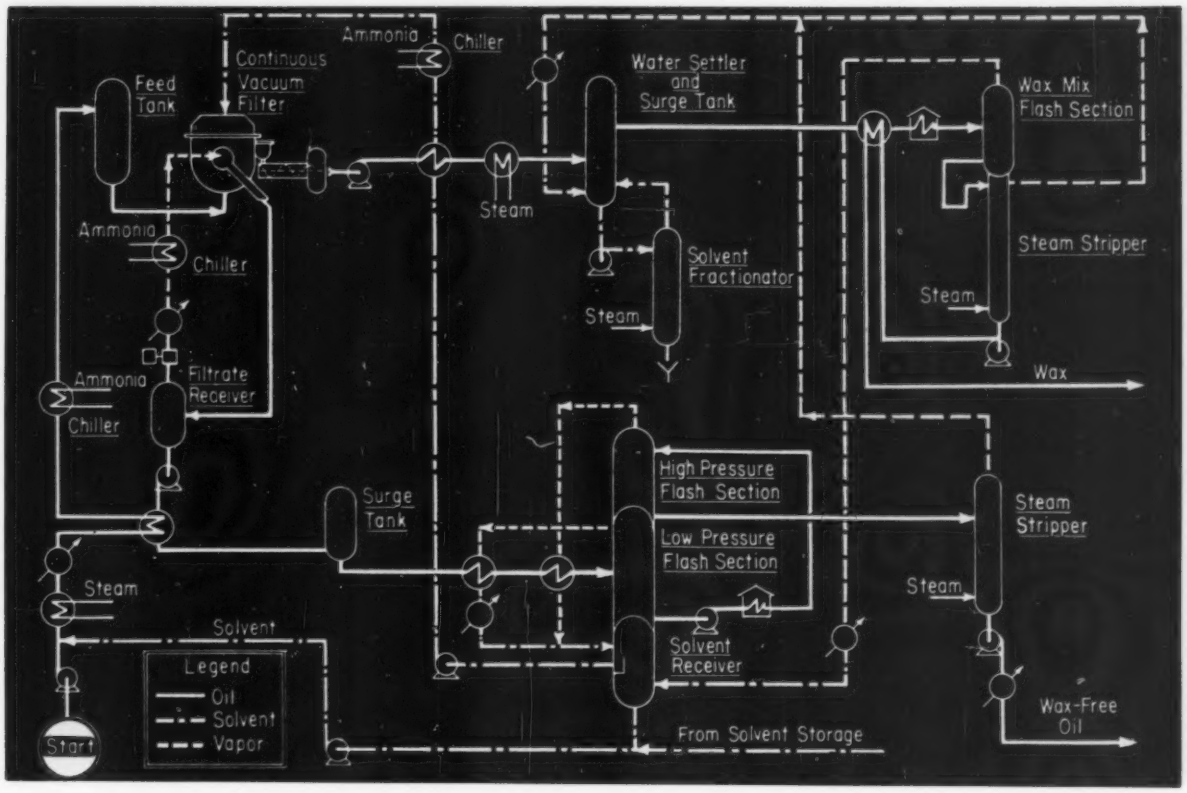
The asphalt solution from the bottom of the decarbonizing tower is heated in a furnace, following which solvent vapors are separated in a pressure flash drum. The final stripping is accomplished at low pressure as with decarbonized oil.

Operating Conditions: Normally, the top temperature ranges between 160 and 220 F. and the pressure from 450 to 600 psi. The solvent ratio and temperature gradient are determined by the selectivity requirements. Solvent composition is adjusted to provide the necessary solubility.

Yields: Typical yields and product properties shown below are illustrative only.

	A	B	C	D	E	F	G
Reduced Crude:							
Volume Percent Crude	11.1	19.8	22.2	32.3	29.2	20.0	16.0
Gravity, °API	11.3	13.0	5.3	10.1	12.0	6.3	9.6
Conradson Carbon Weight Percent	15.0	13.3	21.5	16.0	12.1	22.2	18.9
SSU at 210 F	2,193	812	.....	.....	526	.....	.....
SFs at 210 F	.....	.....	772	162	.....	990	179
SiO_2-Free Ash, ppm	489	149	350	237	936	848	265
Metals, ppm:							
Vanadium	23.1	27.6	84.1	61.6	27.6	136.0	30.0
Nickel	14.2	11.9	27.6	19.9	16.0	139.0	46.6
Iron	18.2	56.6	13.2	6.7	13.2	93.0	39.3
Copper	.....	.....	3.7	0.8	1.6	0.94	1.4
Decarbonized Oil:							
Volume Percent Charge	62.9	69.0	35.0	47.0	66.0	52.8	67.8
Gravity, °API	19.0	20.5	19.3	20.3	19.6	18.3	17.8
Conradson Carbon, Weight Percent	4.2	2.6	4.3	2.6	2.2	5.3	5.4
SSU at 210 F	294	163	193	.....	113	251	250
SiO_2-Free Ash, ppm	9.2	8.9	8.8	7.6	6.2	25.5	10.7
Metals, ppm:							
Vanadium	1.23	0.36	1.88	0.73	1.34	2.3	1.4
Nickel	1.10	0.56	0.92	0.38	0.99	8.1	3.9
Iron	0.49	0.90	0.96	1.70	0.66	3.5	Trace
Copper	.....	.....	0.03	0.04	0.15	0.03	0.02
Asphalt:							
Volume Percent Charge	37.1	31.0	65.0	53.0	34.0	47.2	32.2
Specific Gravity	1.076	1.086	1.087	1.059	1.083	1.119	1.120
R & B Soft, pt., °F	188	196	142	132	171	246	224
Percent of Metals in reduced Crude rejected to asphalt Fraction	97.1	98.8	99.1	98.6	96.6	98.2	97.1

Commercial Installations: At present, there are 12 Propane Decarbonizing units in operation.



Solvent Dewaxing—TEXACO DEVELOPMENT CORPORATION

Application: For the removal of wax from lubricating oil stocks.

Charge: Either distillate or residual stocks of practically any viscosity in the raw or refined state from any crude source can be dewaxed.

Product: Dewaxed oils with pour points equal to or within a few degrees of the dewaxing temperature.

Description: The accompanying flow diagram shows the flow through the unit. In operation, the dilution solvent is introduced into the wax-bearing oil stream in such amounts at selected points in the chilling cycle as to insure a wax crystal structure and liquid viscosity most suitable for filtration.

The chilled charge mixture flows from the double pipe chillers through a filter feed tank to drum-type vacuum filters in which compartmentized, cloth covered drums rotate, half submerged in enclosed filter cases. A wax-free oil filtrate solution is drawn through the filter cloth to filtrate tanks in which the vacuum, which induces filtration, is maintained. The wax cake deposited upon the drum during filtration is washed with cold solvent as it emerges from the liquid level in the filter. Just before each of the filter drum compartments reaches the wax deflector, flue gas at low pressure is admitted through a blow-back connection to the underneath side of the filter cloth. The bond between wax and cloth is broken and the washed wax falls into the wax discharge compartment. Controllers in the flue gas piping maintain an atmosphere pressure in the filter hood.

The filtrate from the filtrate receiver is pumped through the double pipe exchangers to evaporators for recovery of the solvent. Heat for evaporating the solvent from the dewaxed oil solution and the wax mix may be supplied by either stream or fired heaters.

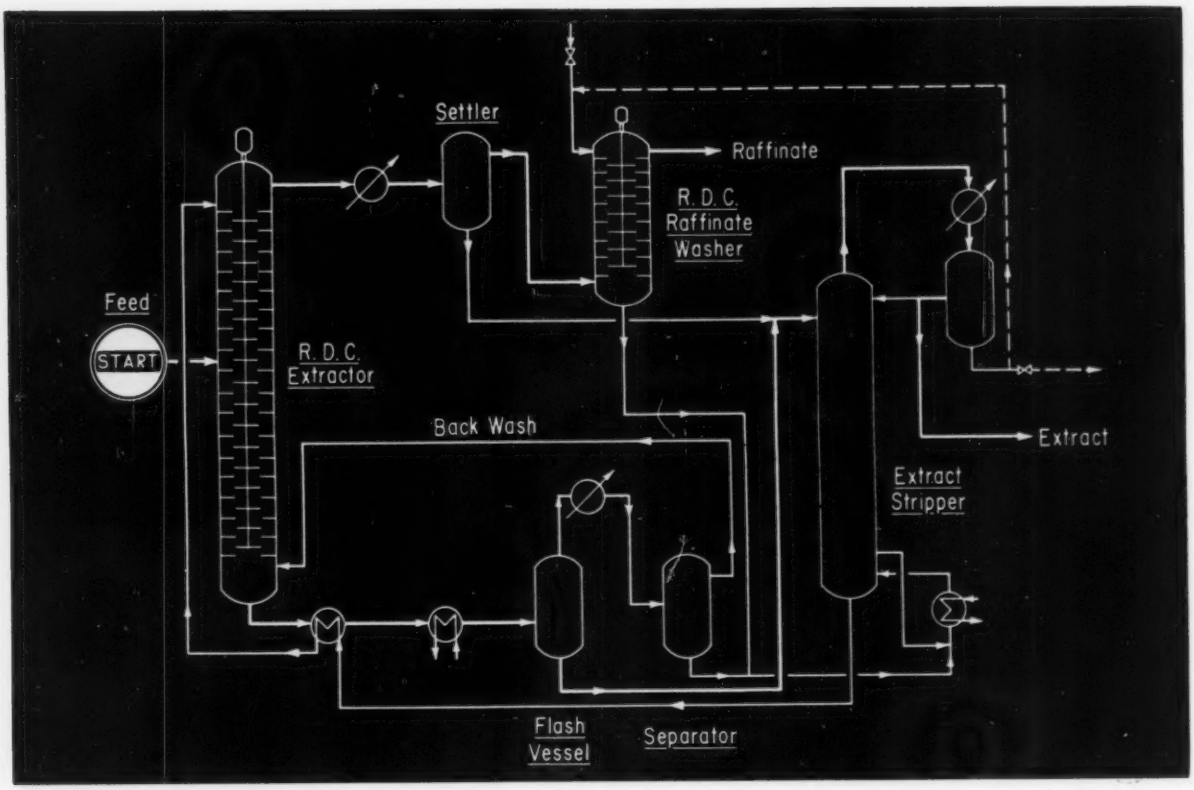
The solvent employed generally consists of a mixture of methyl ethyl ketone and an aromatic solvent (benzol, toluol or a mixture of the two). Because of its relatively low boiling point, the solvent can readily be recovered from the dewaxed oil and wax solutions in simple evaporating equipment for continuous re-use.

Operating Conditions: Dilution solvent dosages vary from a solvent-to-oil ratio of 1.0:1 to as much as 4.0:1 depending on the nature and viscosity of the charge stock. The temperature for dewaxing is dependent upon the desired pour point of the dewaxed oil and is equal to or only a few degrees below the pour point. Low pressures exist throughout the process.

Yields: The yields of dewaxed oil are dependent upon the wax content of the charge stock. Practically complete separation of oil from wax is obtained by the use of the cold displacement wash applied on the filter.

Commercial Installations: Seventy-six units have been installed Two additional units are under construction.

Reference: PETROLEUM REFINER 15, No. 6, 205 (1936).



Sulfolane Extraction—SHELL DEVELOPMENT COMPANY

Application: Extraction of aromatics from catalytic reformates or straight-run fractions for octane improvement. The process can also be used to give high-purity nitration-grade aromatics.

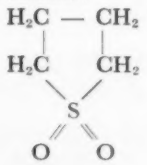
Products: Aromatic extracts for use as blend components of premium gasolines and paraffins raffinates for use as components of jet fuel.

Description: Basically, sulfolane extraction as applied to octane improvement, is similar to other extraction processes. However, it differs in process scheme details and process conditions in accordance with the unique properties of the solvent, sulfolane, which it uses. The flow diagram illustrates the process scheme for the subject purpose.

The plant feed is charged to a rotating disc contactor (RDC) for countercurrent extraction of the aromatic components with sulfolane. Fat solvent from the RDC is flashed after heat exchange with stripper bottoms and further heating. The flash vapors are condensed and collected in a separator, from which hydrocarbon is returned to the RDC as backwash, and water is sent to the stripper reboiler where it is converted to stripping steam. The flash liquid is charged to the top of the stripper, which produces the aromatic extract (top product) and lean solvent for recycle to the extractor.

The raffinate is cooled and, after separation of solvent, is charged to the raffinate washer where water from the extract accumulator and/or fresh process water removes dissolved or entrained solvent from the raffinate, which then goes to storage. The water solution of solvent is charged to the reboiler of the stripper.

Sulfolane is a five-member heterocyclic compound having the structural formula:



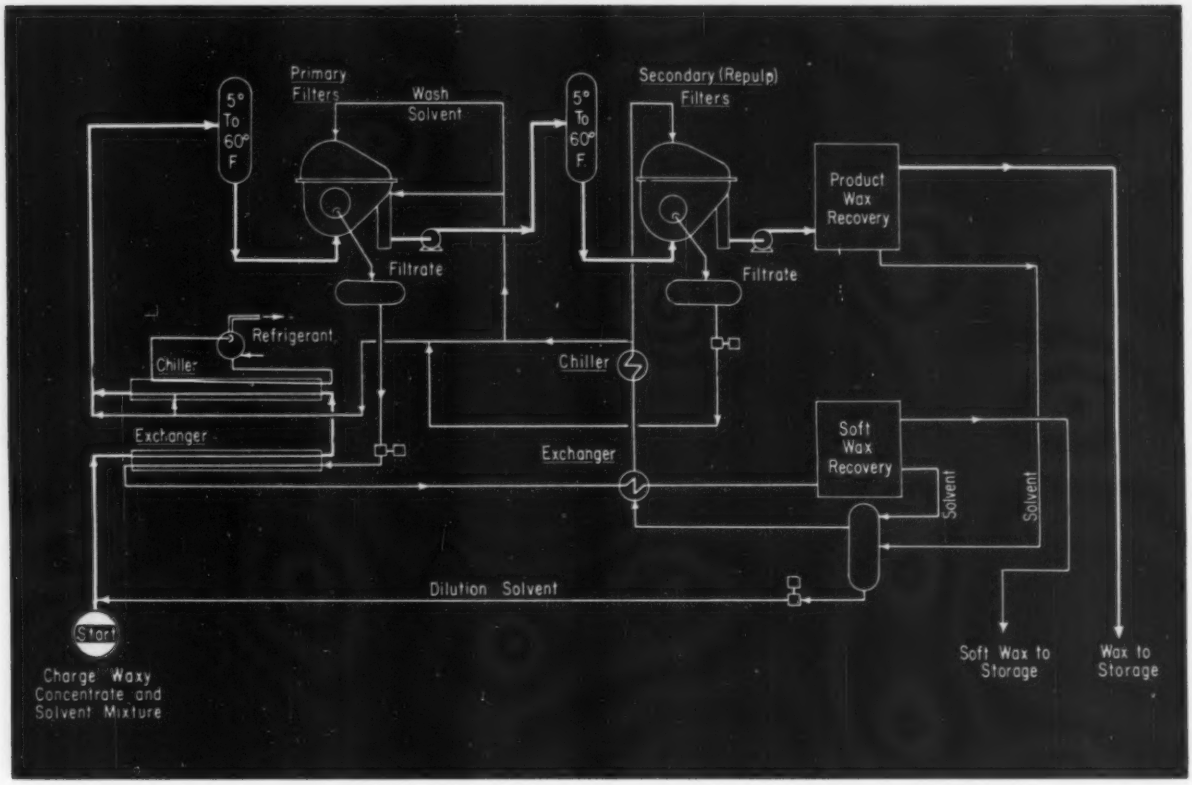
Some of its unique properties are:

Boiling point, °F	549
Freezing point, °F	82
Specific gravity at 212° F	1.20
Viscosity at 212° F, cp	2.5
Heat capacity at 212° F, Btu/lb/°F	0.40
Surface tension at 122° F, dynes/cm	3.7

Yields: Typical results obtained in the sulfolane extraction of a West Texas catalytic reformate having a Research octane rating of 99.5 at 3 cc TEL are:

	Wt. % of Charge	With 3 cc TEL/gal.	
		Research O.N.	Motor O.N.
Reformate Charge	100.0	99.5	90.0
Extract	65.7	110.4	100.0
Raffinate	34.3	75.4	76.1

Reference: PETROLEUM REFINER 38, No. 9, 185 (1959).



Wax Fractionation—TEXACO DEVELOPMENT CORPORATION

Application: For the production of wax of low oil content.

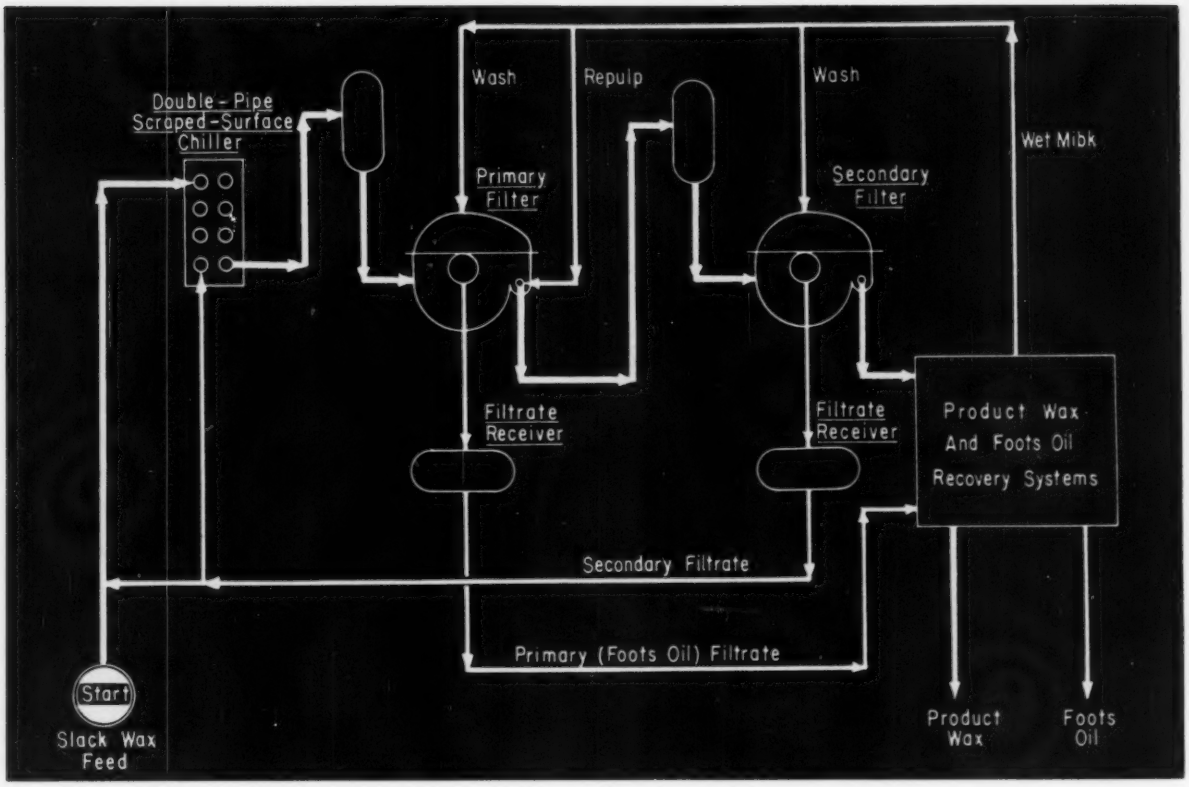
Product: Crystalline and micro-crystalline waxes with melting points depending upon the nature of the charge stock can be produced by this process. Crystalline waxes which consistently show oil contents by ASTM analysis that are below 0.5 percent can be produced. Depending upon the source of the raw waxy concentrate, finished micro-crystalline waxes can be produced which, without additives of any kind, have melting points as high as 200° F. and asphalt penetrations at 77° F. as low as one.

Description: The process employs an operating technique involving the crystallization of wax or a selected portion of the wax contained in a waxy concentrate in the presence of a substantial amount of solvent, added to the charge stock before any of the wax is crystallized. The solid wax is separated from the liquid phase by filtration at a temperature suitable for the desired degree of fractionation.

Typical of the combined operation of the Solvent Dewaxing and Wax Fractionation process is a case in which low pour point dewaxed oil and wax of low oil content are produced concurrently. In the operation, a mixture of the wax-bearing charge stock with a substantial amount of solvent is chilled in double pipe scraped surface chilling equipment to a temperature suitable for the production of dewaxed oil of the desired pour point. The mixture is then filtered and the oil-bearing solution in the wax cake is washed continuously from the wax by displacement with cold solvent. The wax cake is continuously discharged from the primary filters and heated until the wax is totally dissolved in the solvent. Additional warm solvent is blended with the wax cake solution and the mixture cooled in double pipe scraped surface equipment to a predetermined temperature necessary to crystallize the desired wax fractions and obtain the proper quality of wax. The recrystallized wax is then continuously separated by means of a second filter on which the wax receives a final wash. The wax cake from this filter is pumped to the solvent recovery system from which the solvent-free product wax of low oil content is recovered. The filtrate from the secondary filter containing a small amount of oil and undesirable soluble wax fractions is pumped to the solvent recovery system from which the "soft" wax is delivered to storage tanks.

Over-all solvent dosages for a combined dewaxing and wax fractionation operation vary from a solvent-to-oil ratio of approximately 3.5:1 for low viscosity lubricating oil distillate stocks to 9.0:1 or more for viscous residual stocks.

Commercial Installations: Thirty-three commercial installations employ the Wax Fractionation process in the production of high quality waxes. Two additional units are under construction.



Wax Manufacturing, MIBK— UNION OIL COMPANY OF CALIFORNIA

Application: For the production of high quality refined waxes of low oil content.

Charge: High oil content wax fractions, such as slack waxes from the solvent dewaxing of lube oils.

Product: Paraffin and microcrystalline waxes of very low oil contents, high melting points, and other properties desirable in high quality product waxes. Fully refined paraffin waxes of 0.2 percent oil content or less, and refined microcrystalline waxes of 1 percent oil content or less, can be produced routinely.

Description: The process uses water-saturated methyl isobutyl ketone (wet MIBK) as the deoiling solvent. Conventional solvent deoiling equipment is used. The solvent is used in the water saturated condition and no solvent-drying equipment is needed. The process consists basically of the following steps:

- Melted slack wax feed is cooled and wet MIBK is added as required for optimum crystallization. Cooling is done in scraped-surface double-pipe chillers.
- The mixture is filtered through a rotary vacuum filter, and the wax cake is washed with cold solvent.
- The wax cake is slurried, or repulped, with additional cold solvent, and is again filtered and solvent washed.
- The solvent in product wax cake and in the foots oil filtrate is removed in the recovery system.

Fresh solvent ratios of only 1 to 2 volumes (on feed) are typical for paraffin slack waxes. Such low ratios are due to full utilization of the techniques of incremental dilution and filtrate recirculation. In incremental dilution, the solvent is added to the feed in small increments during the chilling process. This gives a slurry of good filtration and wash characteristics. Recirculated filtrate is used as a substitute for fresh solvent at several points in the plant. The oil miscibility and wax anti-solvency properties of wet MIBK permit maximum use of incremental dilution and filtrate recirculation.

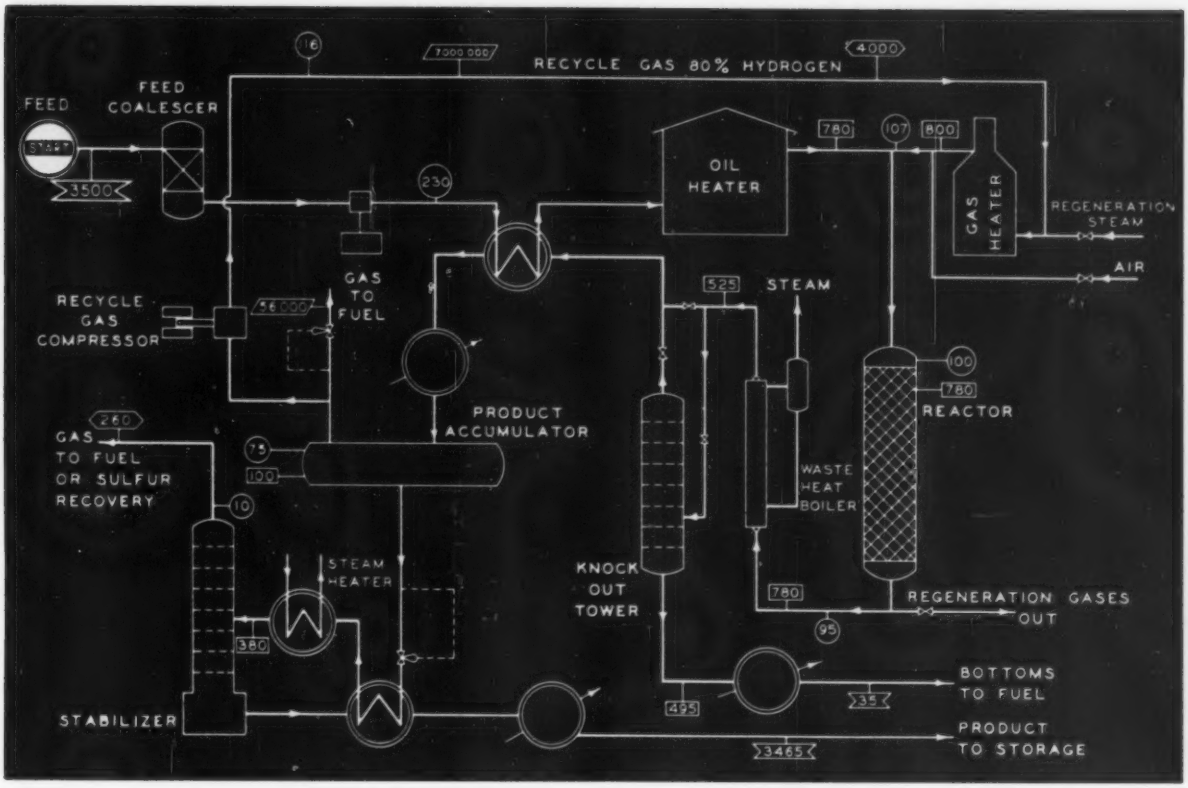
Filtration temperature in solvent deoiling is determined by the properties of the feed, the solvent, and the product wax desired. Experience with wet MIBK has shown that unusually high filtration temperatures (40°-85° F) can be used to obtain a given yield and quality of product wax. This reduces refrigeration costs and minimizes operating problems.

Filter rates are high, being generally in the range of 10 to 30 pounds of dry wax per hour per square foot of filter surface. The rate for a particular installation depends mainly on the characteristics of the feed.

The foregoing discussion is based on a single product wax operation as shown on the flow sheet. The MIBK process can be equally well applied to the simultaneous manufacture of a high-melting "hard" wax and a low-melting "soft" wax. The first filter is operated at a temperature low enough so that the cake will include both the desired high-melting and low-melting waxes. The second filter, operating at a higher temperature, splits the primary cake into two low oil content wax fractions.

Commercial Installations: Union Oil Company of California has operated a wet MIBK Wax Manufacturing Unit at its Oleum Refinery since 1954.

Reference: Petroleum Refiner 37, No. 4, 189 (1958).



Autofining—THE BRITISH PETROLEUM COMPANY LTD

Application: Desulfurizes distillate feeds without requiring an external source of hydrogen.

Charge: Straight-run distillates up to 700° F end point also aromatic extracts and blends with cracked distillates.

Product: With almost complete desulfurization the light products show an increase of 2-4 octane numbers (clear) and a greatly increased lead response.

Description: The process flow is as shown in the flow diagram. The knockout tower is used to remove 1 to 2 percent volume of heavy ends when it is desired to meet the color specification of power kerosine. Granular or pelleted catalyst is used and a life of over eight years has been obtained. Regeneration of the catalyst can be readily accomplished by air/steam or inert gas/air mixtures which restores the full activity.

Operating Conditions: The usual operating temperature range 750°-800° F. Pressures may be held at 100-200 psig by venting excess recycle gas, or allowed to reach equilibrium in the system when the pressure may rise to 600 psig.

Commercial Installations: Three units are in operation. Two of 3,500-bpsd at Llandarcy, Wales and at Aden and one of 500-bpsd at Grangemouth, Scotland.

Yields: Typical yields and properties when operating on Middle East feedstock are shown in the following table.

Method of Operation	Power Kerosine*		Straight-Run Gas Oil	
	Constant Pressure (100 psig)		Equilibrium Pressure (500 psig)	
Yield, Wt % on Feed	99.0		96.0†	
Sulfur Removal, %	70.0		92.0	
	Feed	Product	Feed	Product
°API at 60° F	39.6	40.2	36.3	38.0
I.B.P., F	284	291	482	360
E.P., F	502	500	684	671
Sulfur, Wt. Percent	0.8	0.24	1.25	0.1
F-2 Octane, Clear	52	53	.....	.....
Diesel Index	.....	.....	60	60

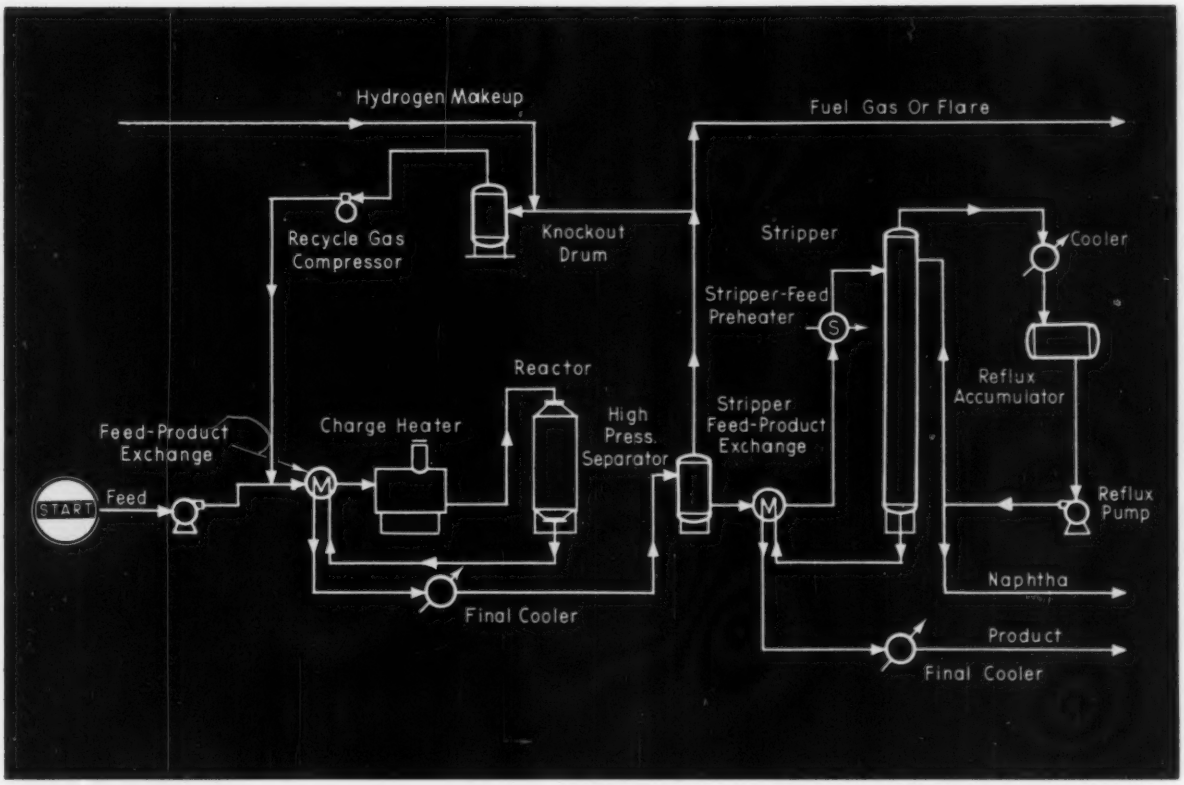
† 1.4 percent weight light ends not included. * Including 10 percent Cat. cracked component.

Economics: Installation costs are $120 to $300 per barrel for capacities from 2,000 to 20,000 bpsd.

Typical operating costs for 10,000 bpsd units are given below.

FEEDSTOCK	Kerosine	Gas Oil
Operating cost, ¢/bbl input:		
Fuel @ 1 $/bbl	2.0	1.8
Power @ 0.8 ¢/kwh	0.8	2.7
Water @ 1 ¢/1,000 US Gal	0.3	0.3
Steam @ 30 ¢/1,000 lb	—1.0	—0.4
Catalyst @ $1.25/lb	0.6	2.5
Labor @ $60/day and supervision @ 15%	2.1	2.8
Total direct operating cost	4.8	9.7
Maintenance @ 4% plant investment	1.9	2.2
Property taxes and insurance @ 2% plant	0.9	1.1
Interest @ 4% and depreciation @ 10% plant	6.6	7.9
Total operating cost ¢/bbl. input	14.2	20.9

Reference: PETROLEUM REFINER 32, No. 12, 84 (1953).



Diesulforming — HUSKY HI-POWER, INC.

Aplication: Diesulforming is a hydrogen treating process that reduces sulfur content of the feed stock. The process also removes nitrogen and oxygen and provides color, odor and cetane improvement.

Charge: The feed stocks which can be processed vary from gasolines to vacuum distillates. Either cracked or straight run are adaptable. The table gives typical inspection data of both the feed and product materials.

Description: The Diesulformer must be closely integrated with a source of necessary hydrogen. The distillate feed stock and hydrogen recycle are preheated by exchange with the reactor effluent before being brought to the reaction temperature in heater. Feed and recycle mixture passes down through the fixed catalyst reactor. After passing through the charge heat exchanger, the reactor effluent is water cooled and goes to the separator where the liquid product is separated from the recycle gas stream which is recirculated by a compressor. Make-up hydrogen is introduced in the suction side of this compressor.

Liquid from the flash drum is stripped of hydrogen sulfide and low flash constituents. The bottom product from stripper is sweet desulfurized distillate. The small volume of H_2S-saturated naphtha recovered from the stripper overhead can be treated like any other sour gasoline.

Materials of construction must be adequate to resist hydrogen and hydrogen sulfide. Concentrations of chromium and molybdenum are effective to prevent hydrogen damage, but certain parts require high chromium steels to withstand hydrogen sulfide.

The catalyst can be regenerated in place by burning off contaminants. Under normal operating conditions, the catalyst is expected to last indefinitely.

Diesulfurization is directly proportional to the temperature and inversely proportional to the space velocity. Secondary variables pressure, purity of hydrogen, and recycle rate are interrelated.

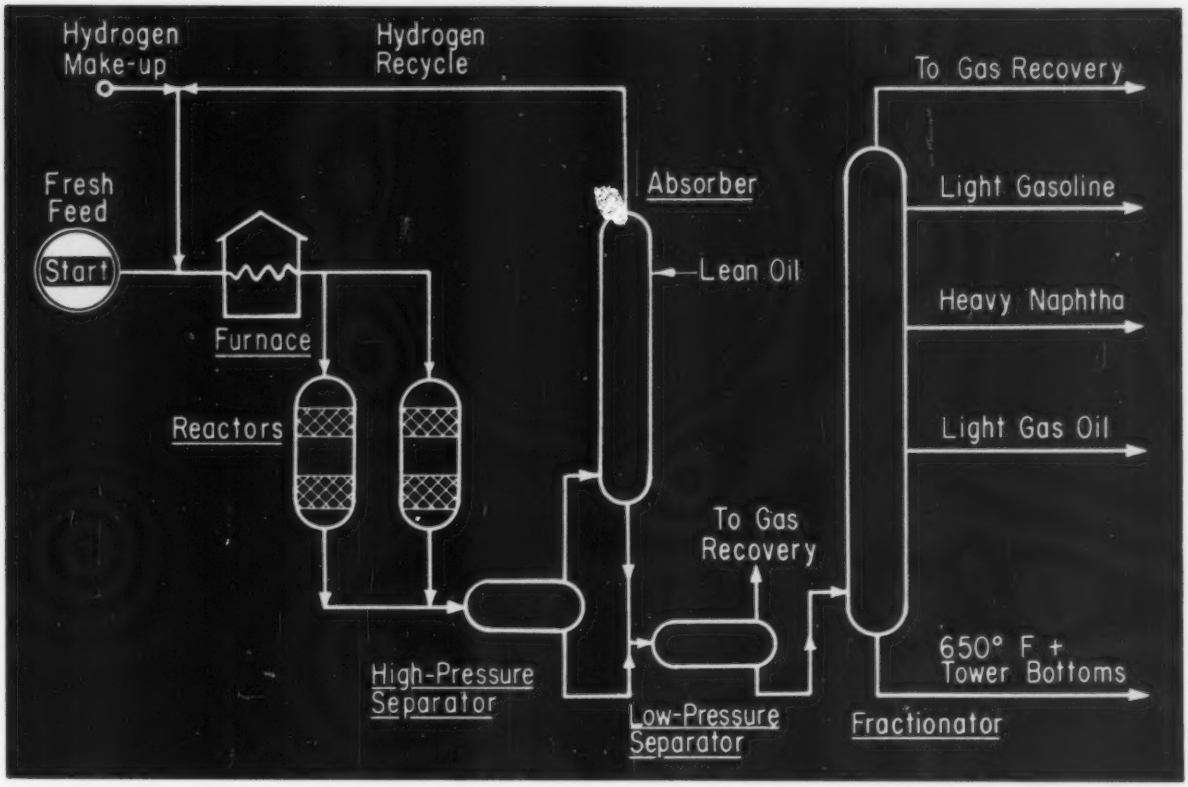
Yields and Operating Conditions:

Space Velocity, W/Hr/W	1–2
Gas Recycle, SCF/Bbl. of Charge	5000
Pressure, psig	300–500
Temperature, °F	600–800

	MED. DIST.		LIGHT DIST.	
	Charge	Product	Charge	Product
Liquid Yield, Vol. Percent	100	100.1	100	100.2
H_2 Consumption, SCF/ Bbl.	....	150	....	92
Total Sulfur, Wt. Percent	2.2	0.35	1.02	0.1
Gravity, °API	30.2	33.2	39.2	40.6
Distillation:				
I.B.P.	473	415	379	363
10 Percent	516	512	408	393
50 Percent	570	564	440	432
90 Percent	624	617	495	488
E.P.	656	658	533	545
Flash, °F	230	152	154	147
Aniline Point, °F	142	152	136	143
Pour, °F	5	5	—50	—50
Doctor Test	....	....	DNP	Pass
Odor	Poor	Good	Poor	Good
Cetane No.	48	58	45	47

Commercial Installation: The first commercial installation was made in the U.S. in 1953 at the Husky Oil Company refinery in Cody, Wyoming.

Reference: Petroleum Refiner 34, No. 9, 158 (1955).



Gulf HDS — GULF RESEARCH AND DEVELOPMENT COMPANY

Application: Upgrades the quality of high sulfur residual stocks by hydrogenation.

Charge: High sulfur residual stocks.

Products: Low sulfur fuel oil or FCC charge stock.

Description: Fresh feed together with hydrogen make-up recycle gas is heated and sent to the reactor. The reactor effluent is cooled and passes to the high-pressure flash drum where the hydrogen rich gas is flashed off. Hydrogen enrichment of this stream may be carried out if desired before recycling to the reactor. Liquid from the high-pressure drum goes to the low-pressure drum where hydrogen sulfide and fuel gas is flashed off. Liquid from the low-pressure drum is fed to the fractionator tower for recovery of a naphtha suitable for reformer charge, a finished light fuel oil of excellent quality, and a 650° F + residual product for use either as a high quality low sulfur content heavy fuel or as a catalytic cracking charge stock, depending upon the degree of hydrogenation employed.

At low HDS severity the residue is treated at about 1,000 psig to remove the bulk of the sulfur and metals with an attendant reduction in viscosity. At the higher HDS severity, complete conversion of the residue is attained with the elimination of heavy fuel oil production. Regeneration of the catalyst is accomplished, when needed, by preheating either a steam or flue gas—air mixture to a temperature of about 750° F and then passing it through the reactor to be regenerated.

Operating Conditions: Normal range of operating conditions vary with the feed stock and the degree of hydrotreating desired, as given below.

Reactor Temperature, F	750-850
Reactor Pressure, psig	500-3,000
H_2 in Recycle Gas, Vol. %	65-90
Space Velocity, V/Hr./V	0.5-2.0
Recycle Gas Rate, scf/bbl.	5,000-10,000

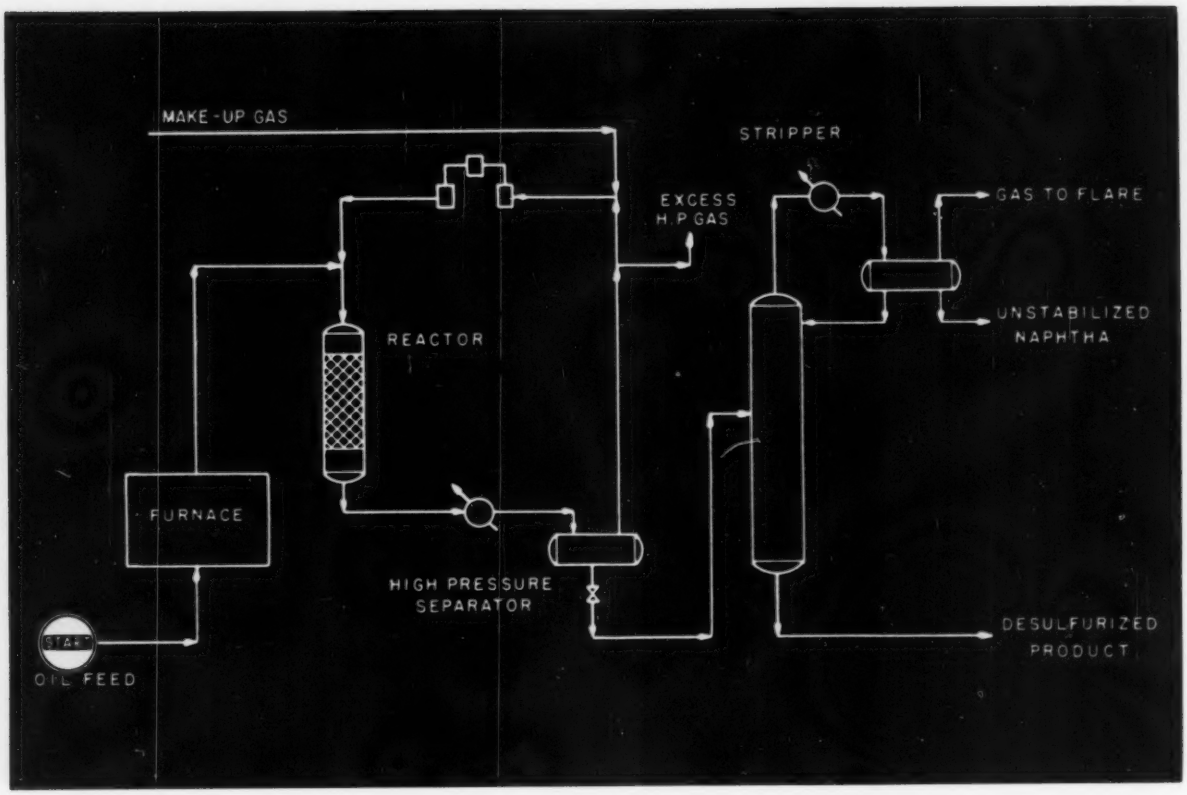
Yields: See accompanying table.

HDS PROCESSING OF KUWAIT RESIDUES

Charge:	18% Vacuum Reduced Crude	44% Atmospheric Reduced Crude
Operating Pressure:	**1000 PSIG**	**3000 PSIG**
Charge Stock		
Gravity, °API	5.5	13.7
Sulfur, %	5.5	4.1
Viscosity, SUV at 210° F	22,130	277
Carbon Residue, %	23.1	9.6
Vanadium, ppm	102	49.5
Product Inspection		
Gasoline (IBP —400° F)		
Yield, Vol. %	5	2
Sulfur, %	0.17	0.04
Aromatics, %	15.0	16.2
Naphthenes, %	21.1	32.1
Furnace Oil (400—650° F)		
Yield, Vol. %	20	12
Gravity, °API	33.7	34.6
Sulfur, %	0.2	0.05
Diesel Index	43.6	40
Residue (650° F +)	Fuel Oil	FCC Charge
Yield, Vol. %	76	88
Gravity, °API	13.0	23.1
Sulfur, %	1.0	0.27
Carbon Residue, %	14.6	2.9
Viscosity, SFS at 122° F	200	.....
Total Nitrogen, %	.....	0.114
Vanadium, ppm	13.2	<0.1
Nickel, ppm	.....	0.3
Characterization Factor	.....	12.07

Economics: See the reference following.

Reference: PETROLEUM REFINER 39, No. 4, 143 (1960).



Hydrodesulfurization — THE M. W. KELLOGG COMPANY

Application: For the removal of sulfur, nitrogen, oxygen and metal compounds from raw naphthas and distillates. For cracked or degraded stocks it simultaneously eliminates unsaturated constituents, restoring color and stability qualities.

Charge: Virgin and cracked naphthas, kerosine, diesel and furnace oils.

Product: Purified and saturated feed naphthas for catalytic reforming, low-color, stable, desulfurized kerosine, diesel and furnace oils and improved catalytic cracking feed and recycle stocks.

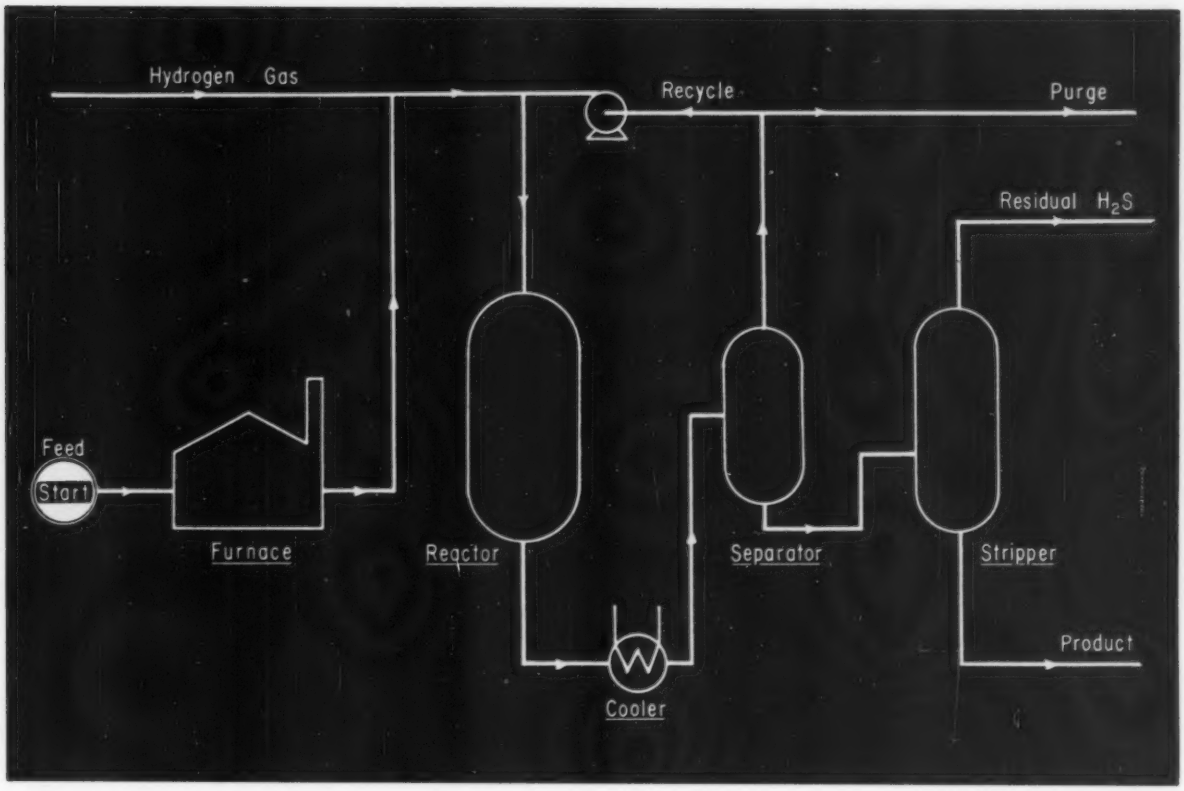
Description: Kellogg Hydrogen Desulfurizing is a mild catalytic hydrogenation process. The incoming feedstock receives preheat against the product stripper bottoms and the total reactor effluent before entering the furnace where it is heated to slightly above reaction temperature. The hydrogen-rich feed gas is compressed to the suction pressure of the recycle gas compressor and combined with the recycle gas stream. After further compression in the recycle machine the gas is heated by the reactor effluent and then mixed with the feed oil at the reactor inlet. The feed oil is sufficiently overheated to raise the recycle-feed gas to reaction temperature, and to provide the heat of vaporization of the oil itself. The reactants flow downward through the catalyst bed where the desired reactions are accomplished. The effluent provides heat to the process and is then flashed in the high pressure separator. The flash vapor is utilized as recycle gas while the liquid is fed to the product stripper. The stripper overhead consists of dissolved gases and light ends; the bottoms is the stabilized product which may be subjected to further processing or sent directly to finished product storage.

Yields: The accompanying table illustrates typical product data for a unit operating on sour middle distillates:

Operating Conditions: Operating conditions vary widely depending upon the type of feedstock and the degree of improvement desired. Reactor temperatures range from 650 to 800 F. and pressures from 350 to 1,000 psia.

Commercial Installations: Kellogg Desulfurization Units, operating and under construction, running feedstocks ranging from kerosine to heavy gas oils account for a combined capacity of over 165,000 bpsd. Naphtha desulfurization units used primarily as catalytic reformer pretreaters, operating and contracted for, amount to an additional 157,000 bpsd, bringing the total capacity to 322,000 bpsd.

	Straight Run Gas Oil		Light Catalytic Cycle Stock	
	Feed	Prod.	Feed	Prod.
Gravity, °API	39.3	40.0	26.6	28.0
ASTM Distillation, °F				
I.B.P.	340	370	420	430
E.P.	600	600	650	650
Sulfur, Weight Percent	0.70	0.05	0.80	0.10
Weight Percent Desulfurization	....	93.0	....	87.5
Fuel Oil, Vol. Percent on Feed	....	96.8	....	98.0
Unstabilized Gasoline, Vol. Percent on Feed	....	3.7	....	3.0



Hydrofining — ESSO RESEARCH AND ENGINEERING COMPANY

Application: Improves the quality of a wide range of petroleum stocks by hydrogen treating. This versatile process may be used to remove sulfur and other impurities or to improve the odor, color, stability and other properties of a variety of products.

Charge: Virgin naphtha, cracked naphtha, solvents, jet fuel, kerosine, diesel fuel, heating oil, lubricating oils and waxes.

Product: Essentially 100 percent of the oil fed to an Esso Hydrofiner is recovered as finished product. Properties of the product will vary with the severity of treatment used in this flexible process. When treating naphthas, Hydrofining will reduce sulfur content and odor and prevent formation of gummy deposits which tend to foul engines. Hydrofining reduces sulfur and improves the odor, color, and burning qualities of kerosine. High quality diesel fuels can be made from sour crudes. Applied to cracked heating oils, Hydrofining reduces carbon deposition and makes these stocks compatible with virgin heating oils. Catalytic cracking feed stocks, which have been Hydrofined, yield more naphtha and heating oil and less gas and carbon than do untreated stocks. Hydrofining improves color, odor, stability, demulsibility, and other properties of lubricating oils. It improves the odor, color and stability of refined waxes. Coal-tar aromatic streams with extremely low sulfur contents have been produced by this process.

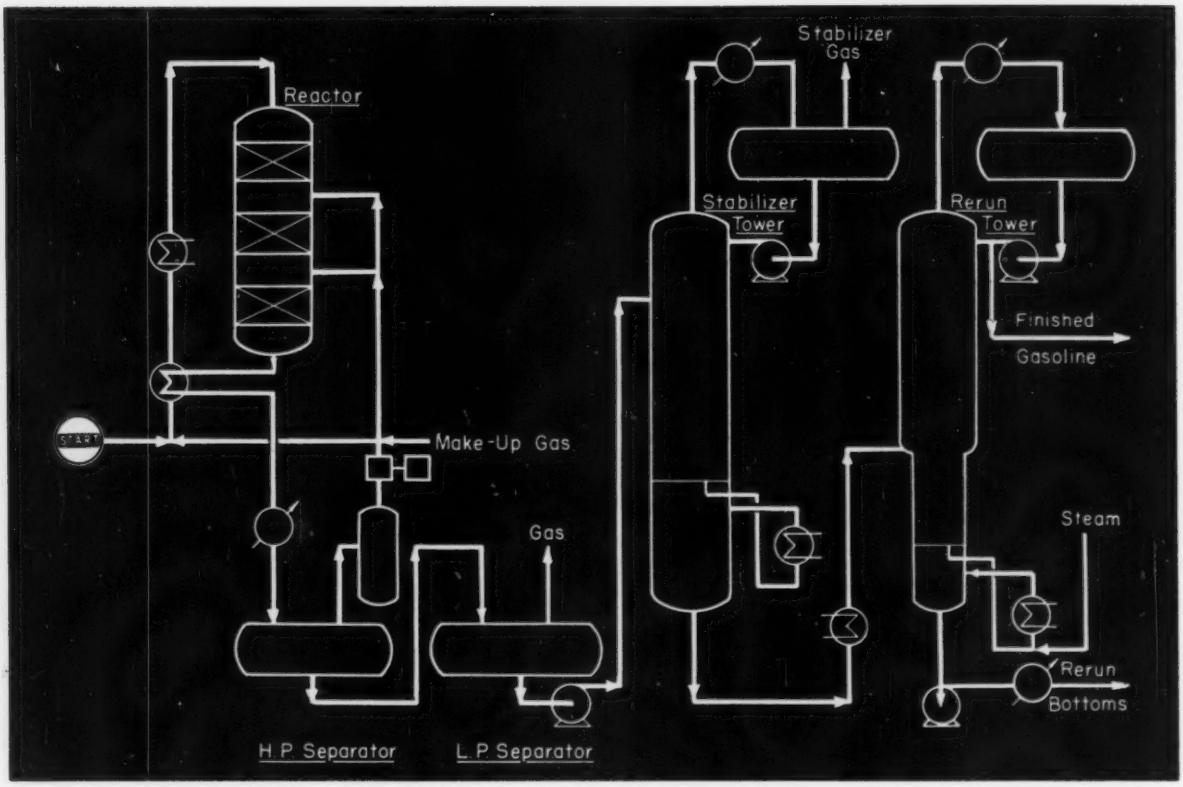
Description: The oil feed enters a coil furnace, where it is heated to a temperature usually between 550° and 800° F. It then passes to a fixed bed reactor vessel together with fresh hydrogen gas. In the reactor, the feed is treated in the presence of the hydrogen and a regenerable metal oxide catalyst at pressures usually between 50 to 800 psi. After leaving the reactor, the product is cooled before entering a separator from which hydrogen-rich gas may be recirculated back to the reactor in amounts varying according to the specific requirements of the finishing operation. After separation, the product stream enters a stripper where any residual hydrogen sulfide gas is removed.

Commercial Installations: The accompanying table summarizes Hydrofining plants built or being built by Esso affiliates and licensees. Slightly more than one-third of the total capacity shown is in the United States with the remainder distributed throughout Canada, Europe, Asia, Africa and South America.

Reference: PETROLEUM REFINER 36, No. 9, 233 (1957).

HYDROFINING UNITS
(Built, Building or Planned)

Principal Feed Stock	No. of Units	Capacity, BPSD
Catalytic Reformer Feeds	26	254,430
Other Naphthas	5	66,640
Solvents	6	18,270
Coal Tar Aromatics	1	1,300
Jet Fuel, Kerosine, Diesel Fuels, etc.	26	244,730
Heavy Gas Oils	2	53,800
Lubricating Oils	6	29,700
Wax	3	4,100
Total	75	672,970



Selective Hydrogenation— THE BRITISH PETROLEUM COMPANY LTD

Application: To refine the gasoline byproduct from steam cracking by hydrogenating selectively the gum forming compounds such as diolefins.

Charge: The gasoline feed is a byproduct from a steam cracking of light naphtha for the production of olefins. The charge has a high octane rating but has poor gum stability.

Product: The finished gasoline is produced in high yield, has excellent gum stability, gives low Lauson engine manifold deposit ratings, shows no loss in leaded octane number and is of improved odor.

Description: The flow diagram illustrates the operation of the process which consists of the following three steps: (1) Reaction of the gasoline feed and hydrogen over a catalyst in a downflow fixed bed reactor. (2) Stabilization of the hydrogenated gasoline to remove hydrogen and light hydrocarbons. (3) Re-running of the stabilized gasoline to produce the finished product as a distillate. For blending purposes, it may be convenient to produce two distillates—a light and a heavy gasoline. The finished products are inhibited with a phenylene diamine type of anti-oxidant.

Operating Conditions: Typical conditions are as follows:

Pressure, psig	300-600
Temperature, °F	up to 350
Space velocity, vol/vol/hr	0.5-5.0
Gas rate (recycle plus make up), scf/bbl	500-1000
Hydrogen absorption, scf/bbl	100-200

Utility requirements per 1000 barrels of feed per day are as follows:

High pressure steam (170 psig), lb/hr	5500
Low pressure steam (40 psig), lb/hr	440
Cooling water (77° F-113° F), U.S. gpm	410
Electricity, Kw	70

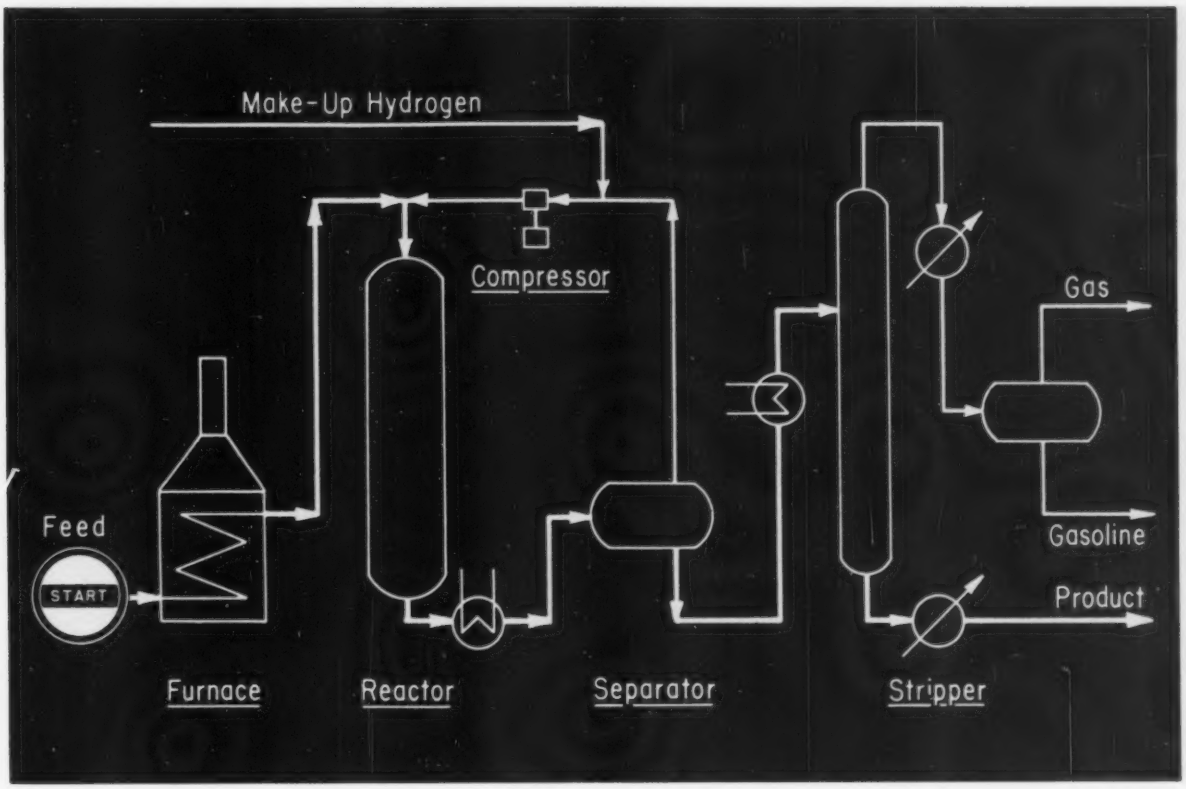
Typical Yields	Weight % On Feed	
Finished Gasoline	96	
Residue	3.5	
Stabilizer Gas	0.5	
Product Quality	**Feed***	**Product***
Gravity, °API @ 60° F	50.8	52.5
Distillation, °F		
IBP	95	102
10%	126	131
50%	187	181
90%	316	295
FBP	369	374
Bromine number	67	52
Gum, existent, mg/100 ml	149	1
Gum, accelerated (120 min.), mg/100 ml	321	2
ASTM induction period, min.	175	>720
Research octane number	92.8	92.4
Clear + 2.25 ml TEL/U.S. gal.	95.4	96.5

* Inhibited with phenylene diamine anti-oxidant.

Economics: All major items of equipment are farbricated of carbon steel. The catalyst cost is cheap and its life is expected to extend over six months. No regeneration equipment has been included in the commercial units.

Commercial Installations: One unit of 2,600-bpsd capacity is in operation and two other units, one of 3,500-bpsd and one of 8,500-bpsd capacity, will be commissioned in 1960.

Reference: White, P. T., Porter, F. W. B., and Yeo, A. A., "Selective Hydrogenation Process for the Refining of Steam Cracker Gasoline," presented at the Fifth World Petroleum Congress, New York, May, 1959.



Trickle Hydrodesulfurization — SHELL DEVELOPMENT COMPANY

Application: Desulfurization of petroleum distillates; removal of nitrogen, hydrogenation of condensed polycyclic aromatics, and removal of heavy metallic contaminants from catalytic cracking feed.

Charge: Distillates ranging from light gasoline to heavy vacuum gas oils and even deasphalted oils.

Description: Hot feed together with hydrogen is charged to an adiabatic reactor. After heat exchange the reactor product is flashed. The flash vapor, consisting mostly of hydrogen, is recycled to the reactor; the flash liquid is charged to a stripper which removes dissolved gases and light ends (gasoline) and gives the final product.

Table 1 illustrates typical results when catalytic cracking feed stocks are hydrogenated. Improvement of cracked or straight-run gas oils is illustrated in Table 2.

Operating Conditions: Pressure may be as low as a few hundred psi and as high as 1,500 psi. Temperature is normally 600° to 800° F, and hydrogen recycle rate is normally under 1200 scf/bbl charge.

Economics: Capital costs range from $50 to $200 per daily barrel thruput. Direct operating costs are normally less than 10¢/bbl of charge.

Commercial Installations: 21 units with a total capacity exceeding 250,000 bpd.

Reference: PETROLEUM REFINER 34, No. 9, 152 (1955).

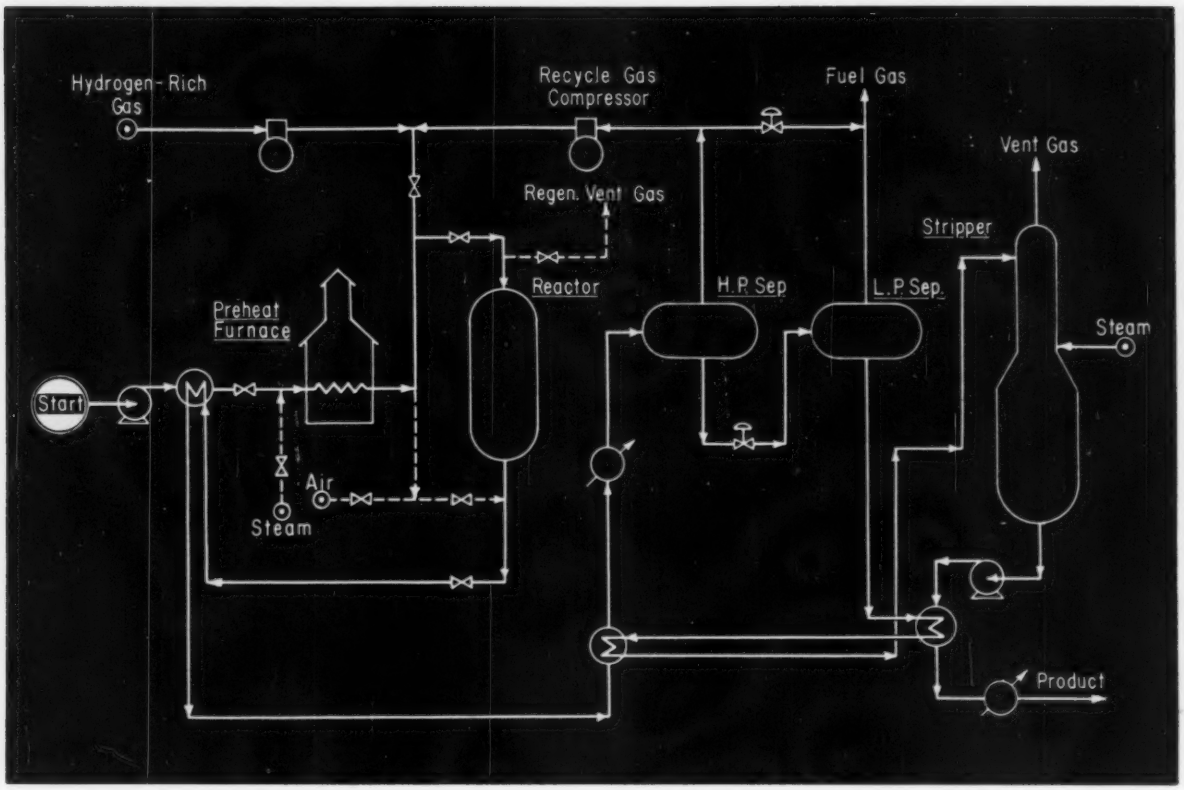
TABLE 1—Hydrogenation of Catalytic Cracking Feedstocks

	West Texas Vacuum Gas Oil		Catalytic Cycle Stock	
	Untreated	Treated	Untreated	Treated
Hydrogenation				
Pressure, psig	.....	1,500	.....	750
Hydrogen Consumed, scf/bbl	.....	530	.....	500
Properties of Catalytic Cracking Feed				
Gravity, ° API	25.5	29.2	21.5	25.7
Sulfur, wt %	1.68	0.05	1.52	0.09
Monoaromatics, wt %	23	25	12	20
Polyaromatics, wt %	21	5	39	24
Catalytic Cracking Yields, wt %				
At Constant Conversion				
Conversion	56	56	50	50
Coke	5.8	2.0	12.6	7.1
Gasoline (C_5-430° F)	33.1	37.5	23.1	28.1
At Constant Coke				
Conversion	49.5	63.4	42.5	56.5
Coke	4.0	4.0	10.0	10.0
Gasoline (C_5-430° F)	31.8	39.0	21.0	29.3

TABLE 2—Hydrodesulfurization of Gas Oil

	Canadian C.C. Light Gas Oil		West Texas C.C. Light Gas Oil		Kuwait S. R. Heavy Gas Oil	
	Feed	Product	Feed	Product	Feed	Product
Yield, vol. %	100.0	101.3	100.0	101.3	100	100.7
Gravity, ° API	24.7	27.9	28.1	31.1	33.0	36.0
Sulfur, wt. %	1.19	0.07	1.08	0.04	1.58	0.14
Nitrogen, wt. %	.056	.041	.019	.010	.012	.007
Diesel Index	24	29	32	36	56	64
Color, ASTM Union						
Without ageing	2	1½	2	1¾	1½	1½
After ageing at 212° F						
for 48 hours	>8	1¾	....	1¾	2*	1½*
for 72 hours	>8	1¾	3¾	2	....	....
Gasoline to 450° F						
Yield, wt. %	8.0	10.0	13.5	17.5	....	....
FIA Analysis, vol %						
Saturates	16	28	30	39	....	....
Olefins	24	1	17	0	....	....
Aromatics	60	71	53	61	....	....
Research Octane Number (Clear)	90.0	94.0	....	....	....	....

* 24 hours.



Ultrafining—STANDARD OIL COMPANY (INDIANA)

Application: Primarily for desulfurization, denitrogenation and olefin saturation.

Charge: A variety of feedstocks ranging from naphthas to heavy catalytic cycle stocks.

Product: Materials having low sulfur, nitrogen and olefin contents and improved stability. See Table 1.

TABLE 1—Typical Ultrafining Applications

	Pretreat Reformer Feed[1]		Make No. 1 Fuel Oil[2]		Upgrade Diesel Fuel[3]	
	Charge	Product	Charge	Product	Charge	Product
Gravity, °API	56	57	41	42	31	33
ASTM Distillation, °F.:						
IBP	175	170	346	349	368	376
10 percent	209	207	386	389	426	426
50 percent	252	251	450	446	494	489
90 percent	323	325	518	515	560	565
Maximum	375	380	552	550	626	631
Olefins, Volume percent	15	1	.....	.....	.....	.....
Bromine No.	29	0.5	.....	.....	.....	.....
Sulfur, weight percent	0.32	0.0030	0.60	0.06	1.10	0.09
Nitrogen, weight percent	0.0031	0.0006	.....	.....	.....	.....
Yield, vol. percent charge	.....	100	.....	98.0	.....	95.5
400°F. EP gasoline	.....	.....	.....	2.8	.....	6.1
Sediment[4]	.....	.....	.....	.....	1.9	0.8
Color, Saybolt	.....	.....	+25	+27	.....	.....
Color, stabil, Saybolt	.....	.....	Poor	+13	.....	.....
Air-Jet Gum, mg/100 ml.	.....	.....	.....	.....	83	20
Floc gum, mg/100 ml.	.....	.....	.....	.....	14.4	5.3
Worrall Burner						
Side deposits	.....	.....	3	0.6	.....	.....
Bottom deposits	.....	.....	13	11	.....	.....
Odor	.....	.....	Poor	Good	.....	.....
Doctor	.....	.....	Sour	Sweet	.....	.....
Cetane No.	.....	.....	.....	.....	36.7	40.8

[1] Remove sulfur, nitrogen, saturate olefins from 60% virgin and 40% coker naphtha.
[2] Remove sulfur, reduce deposits, improve odor and color stability of W. Texas virgin heater Oil.
[3] Reduce sulfur, improve stability and cetane number of feed (84% cat. cycle oil, 16% coker gas oil).
[4] Accelerated aging, 20 hr. @ 200° F.

Description: The reactor is charged with a cobalt-molybdenum on alumina catalyst. Depending upon feedstock, the reactions may be carried out in either the vapor or mixed phase. Catalyst is regenerated at infrequent intervals with steam-diluted air.

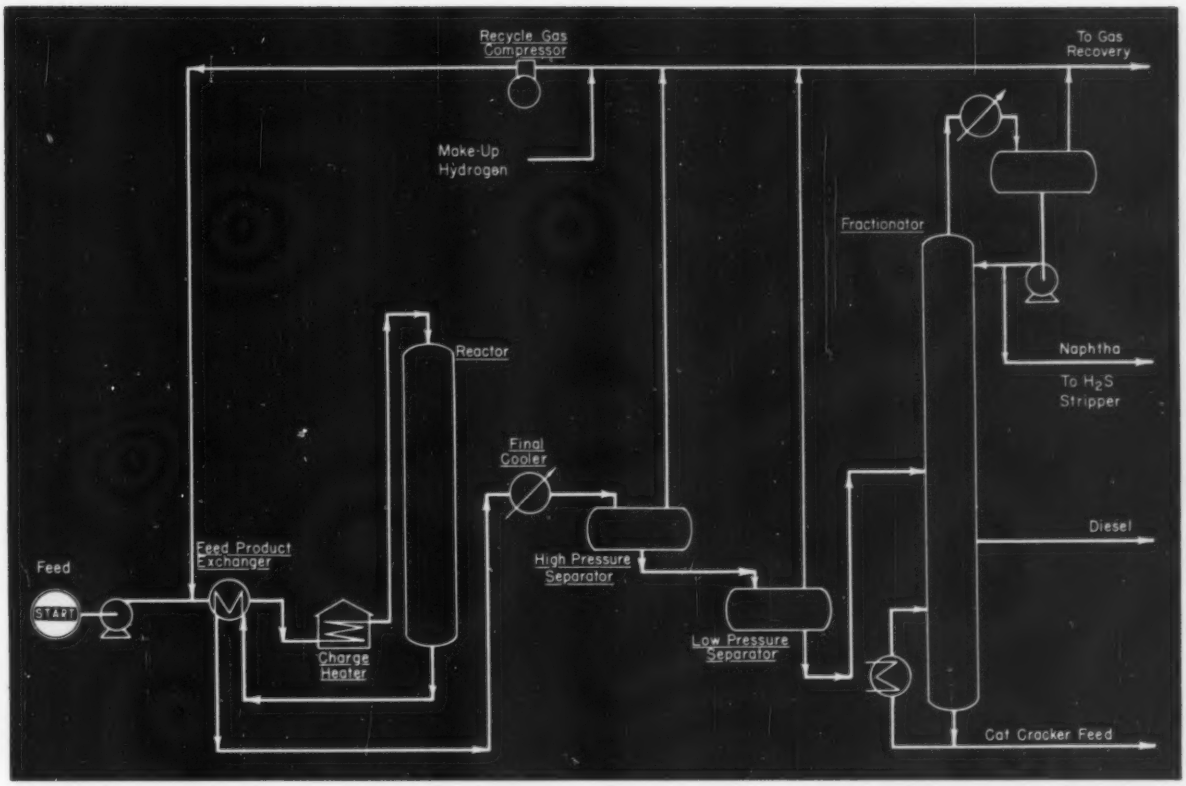
Operating Conditions: Temperatures ranging from 600°-800° F., pressures from 200-1500 psig., space velocities from 1-20 v/hr/v, dilute H_2 addition rates from 500-4000 scf/bbl. and H_2 concentrations of at least 70 mole % in the hydrogen stream.

Economics: See Table 2.

Commercial Installations: In operation are 23 Ultrafiners having a total capacity of about 250,000 bpd.

TABLE 2—Typical Operating Requirements
(8500 B/D cycle oil hydrogenation)

DIRECT CHARGES	
Labor, men	2-3
Maintenance, percent of plant investment/yr.	3-4
Catalyst Life, bbl/lb.	250
Hydrogen, scf/bbl.	170
UTILITIES	
Cooling water, gpm (90°—120° F.)	1860
Steam, lb/hr. 100 psig. 400° F. TT (exclusive of drivers)	2660
Electricity, kwh (exclusive of drivers)	25
Pumps and compressors, THP	220
Fuel, MM Btu/hr.	21
INDIRECT CHARGES	
Royalty, paid-up, $/Bpd	38
Royalty, running, $/Bpd	0.015



Unifining — UNIVERSAL OIL PRODUCTS COMPANY AND UNION OIL COMPANY OF CALIFORNIA

Application: For removing sulfur, nitrogen, oxygen and other contaminants from either straight-run or cracked petroleum fractions.

Products: The objectives of Unifining include: (1) Pretreatment of catalytic reforming feedstocks: (2) Improvement in odor, color, gum and storage stability; (3) Improvement in burning properties of furnace oils, cetane number of diesel fuels, lead susceptibility of gasoline; and (4) Pretreatment of catalytic cracking feedstocks.

Description: The flow diagram shows the equipment arrangement for simultaneous preparation of catalytic cracking feedstock and high quality naphtha and diesel blending stocks from mixed vacuum straight-run and coker gas oils.

The feed is combined with recycle hydrogen, heated to reaction temperature and charged to the reactor. The effluent is cooled and enters a high pressure separator from which recycle hydrogen is taken overhead for return to the system via a compressor. The separator liquid flows to a low pressure separator where additional gases are removed. The liquid product from this separator may be sent to a fractionator, as shown, or to a stripper, stabilizer or comparable equipment.

Yields: See table.

Unifining Gas Oils

	Charge	Naphtha	Diesel	Catalytic Cracking Feed
Gravity, °API	31.4	61.6	34.8	26.4
ASTM Dist., °F:				
Initial	153	95	402	571
50 Percent	665	260	515	728
95 Percent	840	378	624	877
Sulfur, Wt. Percent	1.91	0.05*	0.19	0.53
Conradson Carbon	0.375	.....	0.024	0.247
Metals, ppm:				
Nickel	0.30	.....	.....	0.07
Vanadium	1.90	.....	.....	0.35

* After stripping.

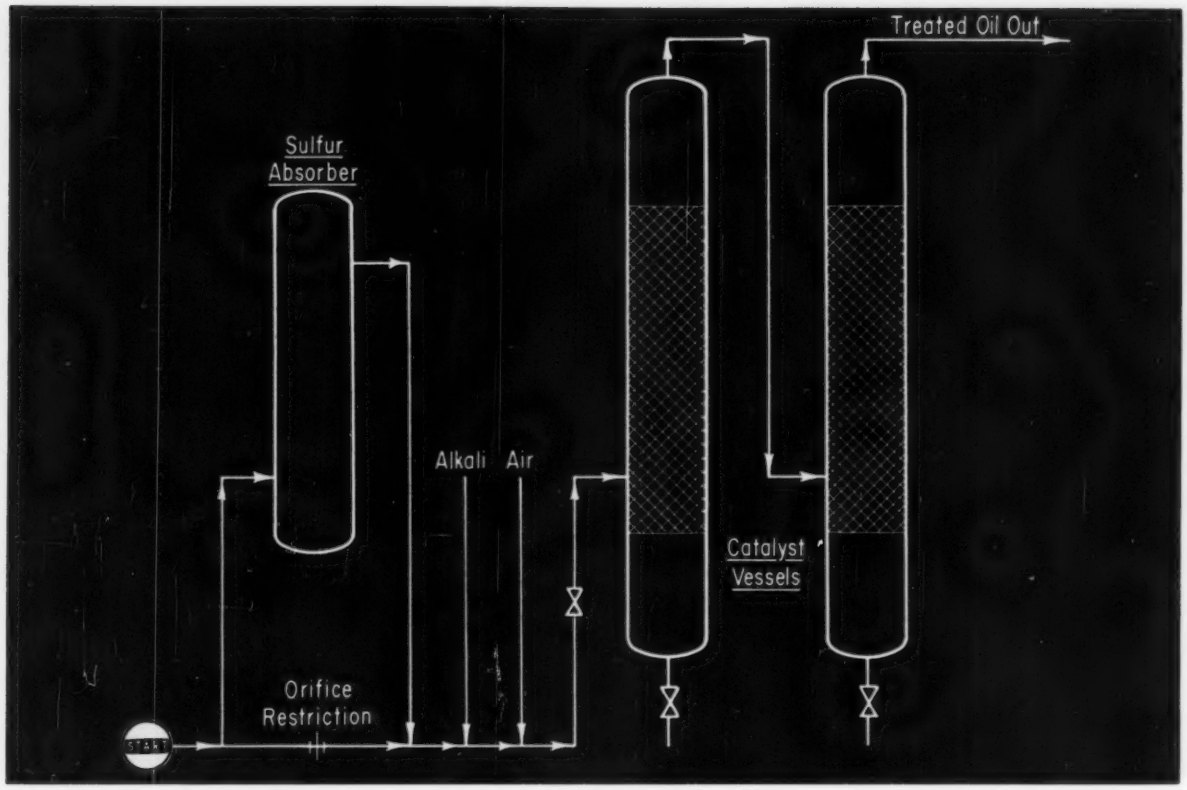
Economics: See table.

Unifining Costs

FEED	Reformer Feed	Stove Oil And Diesel	Wide-Range Distillate	No 2 Heating Oil
Throughput, bpd	16,000	900	5,000	12,000
Direct operating costs, ¢/bbl:				
Labor and supplies, maintenance, utilities	6.3	3.7	5.7	7.7
Catalyst	0.5	0.5	0.7	0.9
Total	6.8	4.2	6.4	8.6

Commercial Installations: Commercial units apply Unifining to straight-run, thermal, catalytic and coker naphthas; straight-run kerosine, diesels, and burner oils; vacuum, visbreaker, and coker gas oils; catalytic cycle stocks, aromatic distillates; and lube oils.

Reference: PETROLEUM REFINER 36, No. 3, 201 (1957).



Bender — PETROLITE CORPORATION

Application: Sweetens distillates, and is particularly applicable for the reduction of mercaptan sulfur in the range of 0.004 to 0.08 weight percent.

Charge: Distillate streams such as gasoline, kerosine, jet fuel, No. 2 fuel oil. It is especially effective in the kerosine-No. 2 fuel oil range. One of the latest most widely found uses is the handling of jet fuel.

Product: A sweet, bright, non-corrosive distillate.

Description: Sweetening is accomplished by converting mercaptans to disulfides in the presence of a fixed bed catalyst. Sulfur is added to the distillate, plus a small amount of alkali (caustic or doctor solution) and air. This mixture is then passed over a bed of solid catalyst. The distillate passes through the catalyst bed rapidly, at rates up to 12 inches per minute.

Hydrogen sulfide must be removed from a distillate prior to Bender Sweetening to maintain the catalyst activity. A caustic prewash can be employed.

When the catalyst has become inactive, it may be reworked at the plant site or replaced by new catalyst.

Some of the process advantages are:

- Simplicity of operation
- Low operating costs
- Uniformly sweet and non-corrosive product
- Eliminates pollution
- No product loss
- No continuous regeneration
- Low installation cost
- Small plant area required.

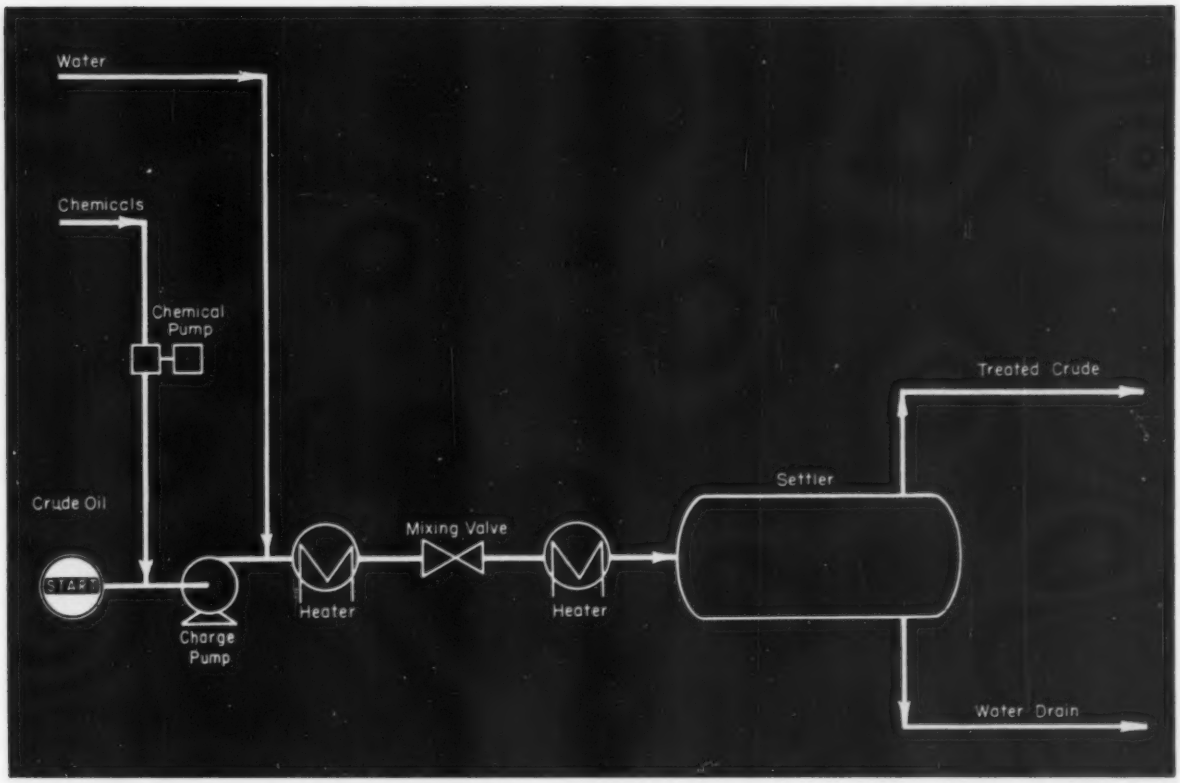
Operating Conditions: Gasoline and naphthas, in general, require 1.0 to 1.25 theoretical equivalents of sulfur. Kerosines, light gas oils, etc., require 1.5 to 2.0 theoretical equivalents. By contrast, conventional doctor treating requires 30 to 100% more sulfur than these amounts.

A small amount of caustic is added to the distillate to maintain the effluent in a slightly alkaline state. Air requirements are moderate; and may be supplied from instrument air systems for smaller distillate streams. The operating temperature depends on the distillate to be processed: Gasoline is about 90° F, stove oils approach 140° F. Normally, a back pressure of 20 psi minimum is maintained on the unit.

Economics: Installation cost for this process is estimated to be in the range of $15 to $30 per barrel per day of thruput. The total treating costs, exclusive of amortization, average close to 0.5 cents per barrel of charge. Making up this cost are such items as labor, catalyst maintenance, sulfur, NaOH and utilities. The amortization costs will vary from plant to plant, but a spread of 0.5 to 1.0 cents per barrel of daily charge will cover most cases. Amortization is calculated on a basis of ten years. If total treating costs and amortization costs are added, the over-all expense of a Bender treating plant will average under 1.5 cents per barrel.

Commercial Installations: Sinclair Refining Company and its affiliates have four units in operation. Since Petreco has been designated as exclusive sublicensors, 13 more plants have been installed.

Reference: PETROLEUM REFINER 34, No. 9, 182 (1955).



Chemical Desalting

Application: To remove inorganic salts from crude oil so that these salts will not be present to cause plugging of exchangers, coking of furnaces, and corrosion. The process also provides removal of arsenic and other trace metals which act as poisons to catalytic cracking catalysts.

Charge: Crude oil.

Product: Crude containing five to ten pounds or less of salts per thousand barrels.

Description: The salts normally present in a crude oil can be retained in a refinery charge as crystalline suspensions and as entrained solutions with water. These salts break down during processing to form acids which increase corrosion. They also deposit in exchangers and tube stills to limit flow and cause hot spots. Some of the metallic constituents of the salts as catalyst poisons.

The salts are held in the crude oil by an organic film. They can be separated from the oil by water washing in the presence of special chemicals tailored to suit the type of salts present and the nature of the crude oil. The accompanying flow diagram shows a typical chemical desalting process.

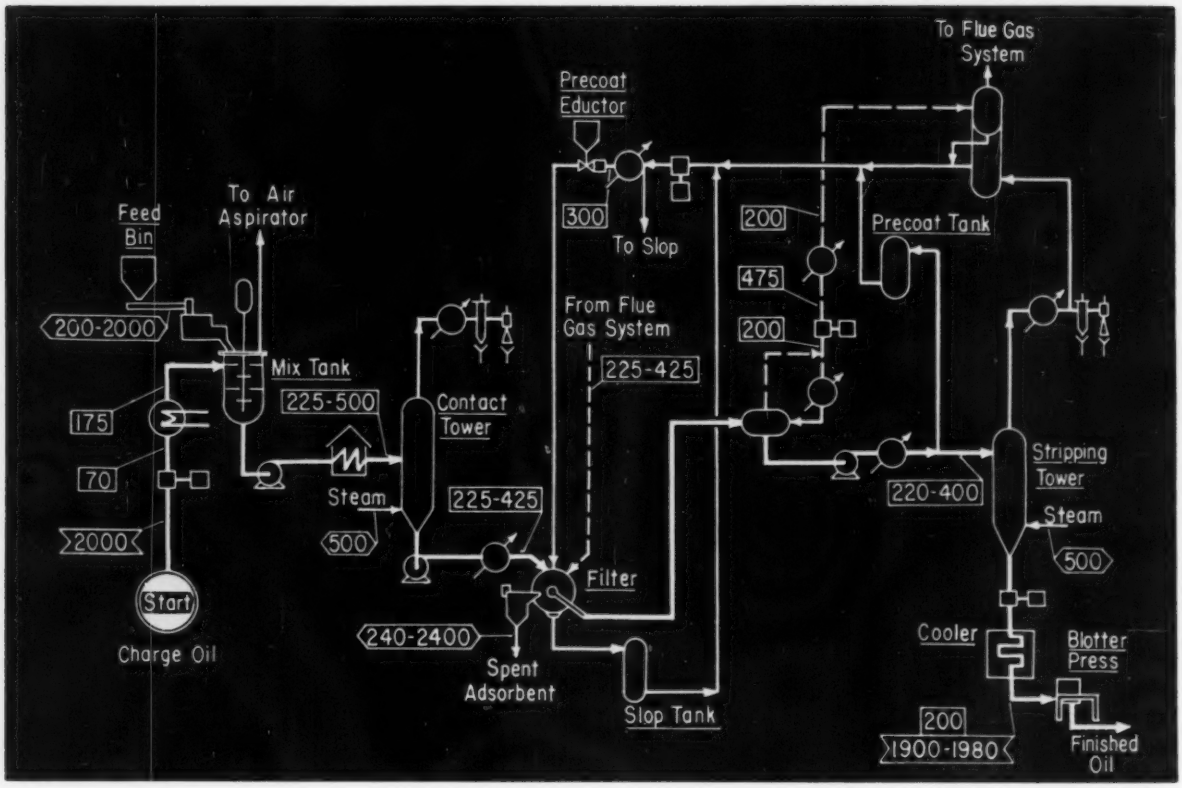
The chemicals are added to the process stream with a pump which is usually of the positive displacement type. They are added upstream from the charge pump so they will become thoroughly mixed with oil. Caustic or acid may be part of the chemical mixture or either may be added separately later to adjust the pH of the solution.

Process water is used to dissolve the salts not already in solution. To assure good contact between the water and the crude, they are passed through a mixing valve to form an emulsion. In some cases the water is added upstream from the charge pump so that the emulsion is formed by the pump impellers.

The process is carried out at elevated temperatures. The temperatures vary from 150° to 350° F. depending upon the type of crude being processed. The heat lowers the surface tension of the oil, allowing water particles to coagulate easier. The heat also reduces the viscosity of the oil, giving less resistance to separation of the salt laden water.

A settler provides a quieting zone following the heat exchanger. The settler is often designed to allow settling times from 20 to 60 minutes. It may be equipped with baffles to reduce flow turbulence and channeling. Crude oil leaves the top of the settler while salts are withdrawn as a solution with the drain water.

Reference: Kalichevsky, Vladimir A. and Kobe, Kenneth A., *"Petroleum Refining with Chemicals,"* Elsevier Publishing Co., New York, p. 8 (1956).



Continuous Contact Filtration — FILTROL CORPORATION

Application: Principally for the refining of lubricating oil stocks, but it is also applied successfully to the finishing of waxes and specialty oils.

Charge: Petroleum hydrocarbons in the lubricating oil or specialty oil range that have been solvent extracted, acid treated. Solvent extracted stocks are dewaxed, usually, before charging.

Product: Finished lube oil or specialty oil base stocks ready for blending and compounding.

Description: The flow diagram shows the operating conditions (minimum and maximum) for a hypothetical unit processing motor oil base stocks ranging in viscosity from light neutrals to bright stocks at an average rate of 2,000 barrels per day. Larger and smaller feed rates are employed also.

The adsorbent is added to the oil charge and the oil-adsorbent slurry enters a pipe still heater where maximum contact temperature is obtained in a once through operation. From the heater the slurry enters a stripping tower where a level is maintained regulating the time of contact. Steam is passed through the slurry and up the tower to facilitate the stripping action. The slurry is drawn continuously from the bottom of the tower to a vacuum filter. The filtered oil is charged to a high vacuum stripper to furnish additional product control.

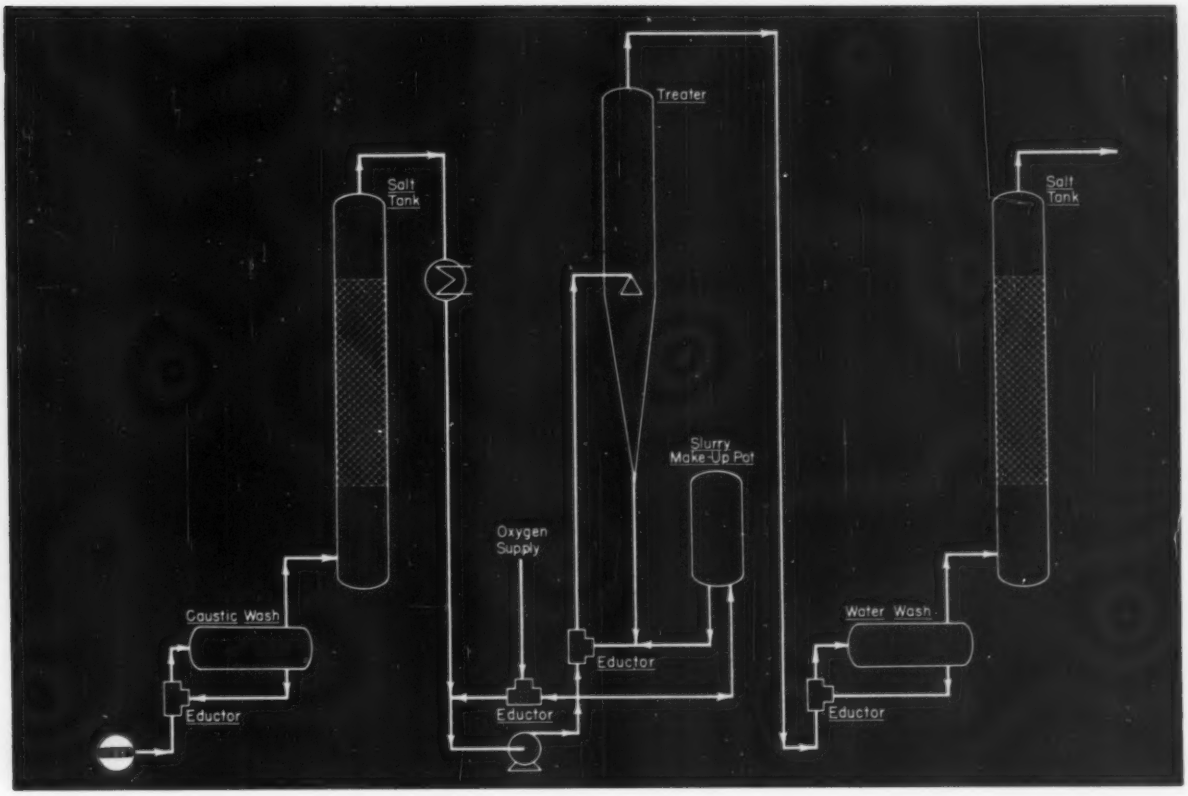
The oil is finally pumped through a blotter press, cooler and to storage.

Yields: Yields are a function of the type of oil charged and the quantity of adsorbent used. Normally, yield approximates 98.5 percent of oil charged.

Contact Filtration is a mild refining step, polishing and decolorizing the oil and improving inspections such as carbon residue, oxidation, neutralization number and emulsibility-demulsibility.

Typical Inspections of Lubricating Oils

	Turbine Oil		Phenol Raffinate	
Determination	**Before Contact Filtration**	**After Contact Filtration**	**Before Cont. Filt.**	**After Cont. Filt.**
Gravity, °API	23.0	23.1	22.6	22.6
Color, ASTM	3	2	4	1½
Viscosity, S.S.U. @ 100 F.	508	495	372	364
Flash, °F	395	410	395	400
Fire, °F	455	455	440	440
Neutralization No.	0.03	.....	0.9	0.02—
Steam Emulsion No.	1200+	20—	.....	.....
Conradson Carbon Residue	.....	.....	0.03	0.02



Copper Sweetening—LINDE COMPANY

Application: For converting organic mercaptans to disulfides.

Charge: Straightrun gasoline, thermally and catalytically cracked gasolines, kerosine, special solvents, and distillates.

Description: Hydrogen sulfide is removed by prewash, using sodium hydroxide or sodium carbonate. Excess moisture is removed by passing the sour hydrocarbon stock through a salt tank. The stock then flows through a heater (temperature increase 5° to 25° F.) to dissolve water formed in the sweetening reaction.

From there, the sour hydrocarbons flow to a centrifugal pump. About 10 percent of total stock is pumped through an eductor back into the suction side of the pump. Pure oxygen, for regeneration of the copper chloride, is added to this bypassed portion and becomes uniformly dispersed in the main stream.

The stream then passes through another eductor, connected to the cone bottom of the treating tank. The copper chloride, clay and hydrocarbon flow as a slurry from the bottom of the treating tank into the eductor, where it contacts intimately the oxygen and sour hydrocarbons, resulting in immediate sweetening. Rapid regeneration of the copper chloride is achieved. When necessary, fresh clay and copper chloride can be added by way of the slurry make-up pot.

The slurry mixture flows into the treating tank, where the copper-chloride clay mixture settles to the bottom to be used again. From the top of the treating tank, the stock passes through a water wash tank and then through a final salt tank for removal of entrained water.

For straightrun gasoline, no further treatment is required. For cracked gasoline, and in some cases kerosine, a small amount of metal deactivator is added to counteract the possible detrimental effect of dissolved copper compounds.

General Operating Specifications

Precaustic Wash Tank—for Removal of H_2S:
Sodium Hydroxide Solution—5% to 10% by weight.
Settling time—45 to 60 minutes (gasoline) or 45 to 75 minutes (kerosine or No. 1 heating fuel).
Contact ratio, sodium hydroxide solution to stock—1:4.

Salt Tank—for Removal of Suspended Liquid: Maximum velocity through salt, based on empty tank—75 ft./hr. (gasoline) or 30 ft./hr. (kerosine or heating oil).
Quantity of salt, (minimum)—30 lbs./bbl./hr. (gasoline) or 75 lbs./bbl./hr. (kerosine or heating oil).

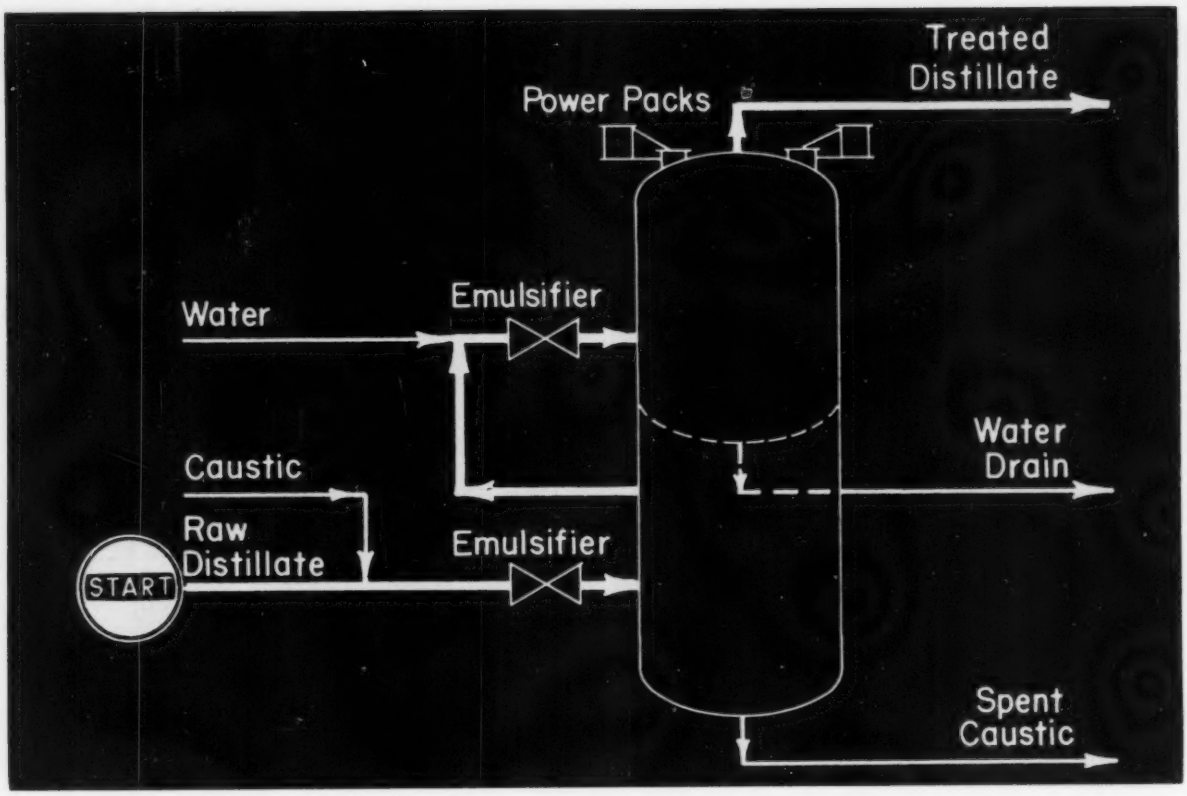
Oxygen: Theoretical oxygen required—0.01 cu. ft./bbl./hr./mg. mercaptan S/100 cc. or 0.07 cu ft./bbl./hr./0.01% mercaptan S for 0.7 specific gravity.
Actual oxygen consumption 1½ times theoretical.

Treating Tank: Maximum velocity above cone—
Straight run gasoline, acid treated cracked gasoline and similar stocks—5"/min.
Kerosine, No. 1 heating fuel, raw pressure distillate, thermally and catalytically cracked gasoline and poly gasoline—3"/min.
Settling time above cone—24 to 40 min.
Concentration Cupric Chloride in Slurry:
10% by wt. for less than 10 mg. mercaptan S/100 cc.
15% by wt. for 10 to 20 mg. mercaptan S/100 cc.
20% by wt. for more than 20 mg. mercaptan S/100 cc.
Water of Reaction: $2\ RSH + O \rightarrow R_2S_2 + H_2O$
1 mg./100 cc. RSH = 3.9 PPM H_2O
Discharge pressure at centrifugal pump: approx. 100 psig.
Pressure drop across eductor: 60 to 80 psi.
Pressure in treating tank: 20 to 40 psi.

Water Wash Tank: Settling time—30 to 45 min. (gasoline) or 45 to 75 min. (kerosine or No. 1 heating oil).
Contact ratio, water to hydrocarbon stock—1:4.

Sodium Sulfide Wash: Composition: 6 to 10% Caustic Soda
3 to 6% Sodium Sulfide
Settling time—45 to 60 min. (gasoline) or 45 to 75 min. (kerosine or No. 1 heating fuel).
Contact ratio, sodium sulfide solution to stock—1:3.

Deactivator: The quantity of deactivator required varies from ¼ to 2 lbs. per 1,000 barrels of processed stock. Variation depends on copper content and nature of stock.
1 lb. deactivator per 1,000 bbls. = 3.8 ppm.



Distillate Treating — PETROLITE CORPORATION

Application: For contacting a light hydrocarbon stream with a treating agent (acid, caustic, doctor, etc.) then separating the chemical phase from the treated hydrocarbon product.

Charge: Light hydrocarbons such as gasoline, kerosine, diesel fuel, jet fuel, furnace oils, transformer oils and lube distillates.

Product: Treated light hydrocarbons, free from carry-over, stable, ready for blending or shipping.

Description: Treating chemicals such as acid, caustic or doctor solution are dispersed into the hydrocarbon stream to be treated. The volume of chemical dispersed, the degree of dispersion desired, and the time and intensity of contact are all automatically controlled. The chemical-hydrocarbon mixture is then subjected to the action of the electrostatic field in an Electrofining treater. The electric field coalesces the dispersed phase; the acid sludge, spent caustic or doctor solution then separates from the continuous phase.

The process is extremely flexible, with options of single-stage or two-stage treaters available. Various concentrations of caustic can be efficiently applied and separated. Acid treating, or acid-acid sludge treating in series can be effected. Doctor treating, three phase treating, sulfonation and water washing are other possible alternatives. The flow diagram illustrates one of the many broad applications possible.

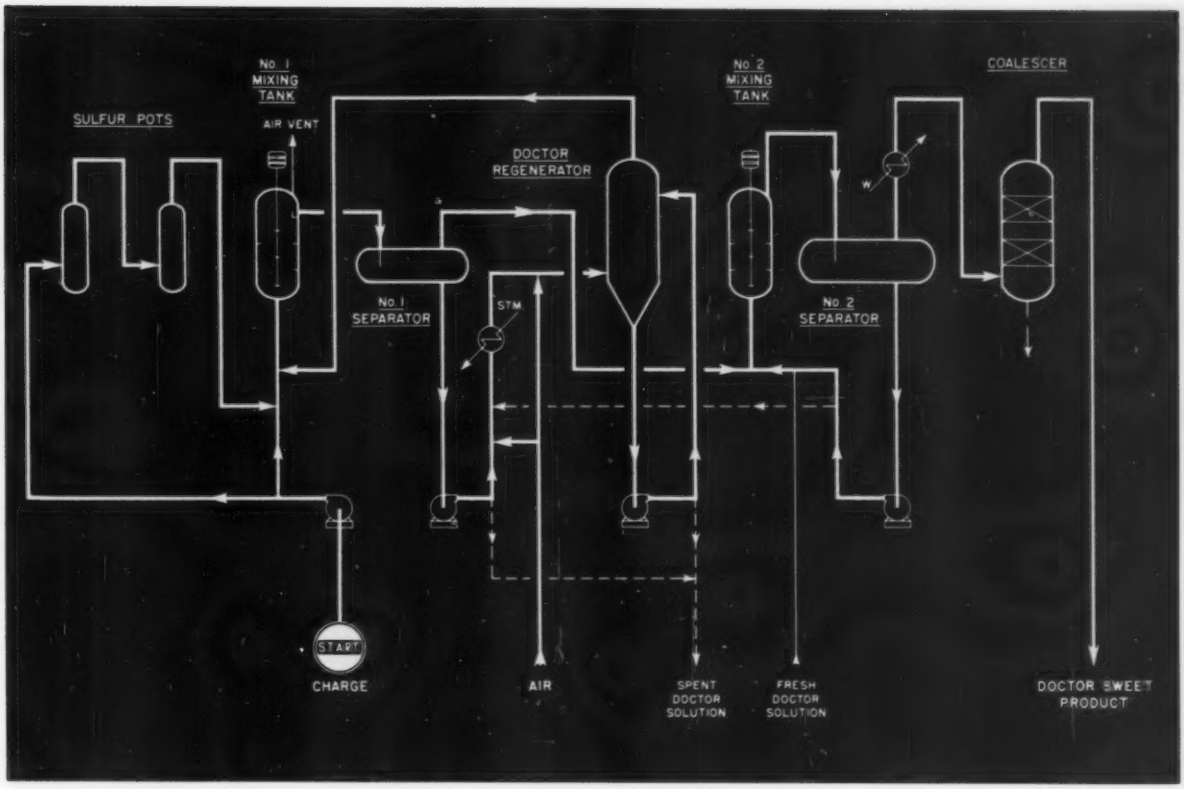
Operating Conditions: Electrofining treaters operate at the normal temperatures at which the hydrocarbon to be treated flows to the run down tanks or storage. A pressure of 25 psi, or more, is required to hold the hydrocarbons in a liquid phase. A power consumption of about 1 kw is normal at the usual power voltage of 460 volts, 60 cycles.

Product Specifications: The product quality varies with the hydrocarbon processed and the treating agent. However, in plants currently operating, it can be stated that the products are usually characterized as doctor sweet, stable in color, low in metal ions and RSH, free from carry-over and capable of passing the usual specification tests.

Economics: Treaters varying in size from 400 bpd to 40,000 bpd have been installed at a total cost of $5 to $20 per daily barrel charge.

Commercial Installations: There are 106 Electrofining treaters in operation or under construction, processing 77 streams in North America and abroad.

Reference: PETROLEUM REFINER 34, No. 9, 184 (1955).



Doctor Sweetening— THE LUMMUS COMPANY

Application: To sweeten gasoline, solvents, and kerosine by converting mercaptans to disulfides.

Charge: Sour hydrocarbon stocks including gasoline, solvents and kerosine.

Description: Doctor sweetening, one of the oldest processes for sweetening gasoline, solvents and kerosine, converts mercaptans to disulfides using sodium plumbite and sulfur,

$$2\,RSH + Na_2\,PbO_2 \rightarrow PbR_2\,S_2 + 2NaOH$$
$$PbR_2\,S_2 + S \rightarrow PbS + RSSR.$$

The PbS is converted back to $Na_2\,PbO_2$ by air blowing in caustic soda.

$$PbS + 2O_2 + 4NaOH \rightarrow aN_2\,PbO_2 + 2H_2O + Na_2SO_4$$

In this process, sulfur and caustic soda are consumed. In addition, some PbO is mechanically lost and some must be added to replace solution discarded because of the accumulation of sodium sulfate and sodium salts of cresols and aliphatic acids.

In this unit, a slipstream from the charge stream passes through sulfur pots, and rejoins the main charge stream along with regenerated doctor solution and regeneration air at the bottom of the No. 1 doctor mixer. The sour charge, sulfur solution and regenerated doctor solution are intimately mixed in the No. 1 doctor mixer. Air is vented from the top of this mixer, and the treated charge plus doctor solution flow out through a side nozzle to the No. 1 doctor separator.

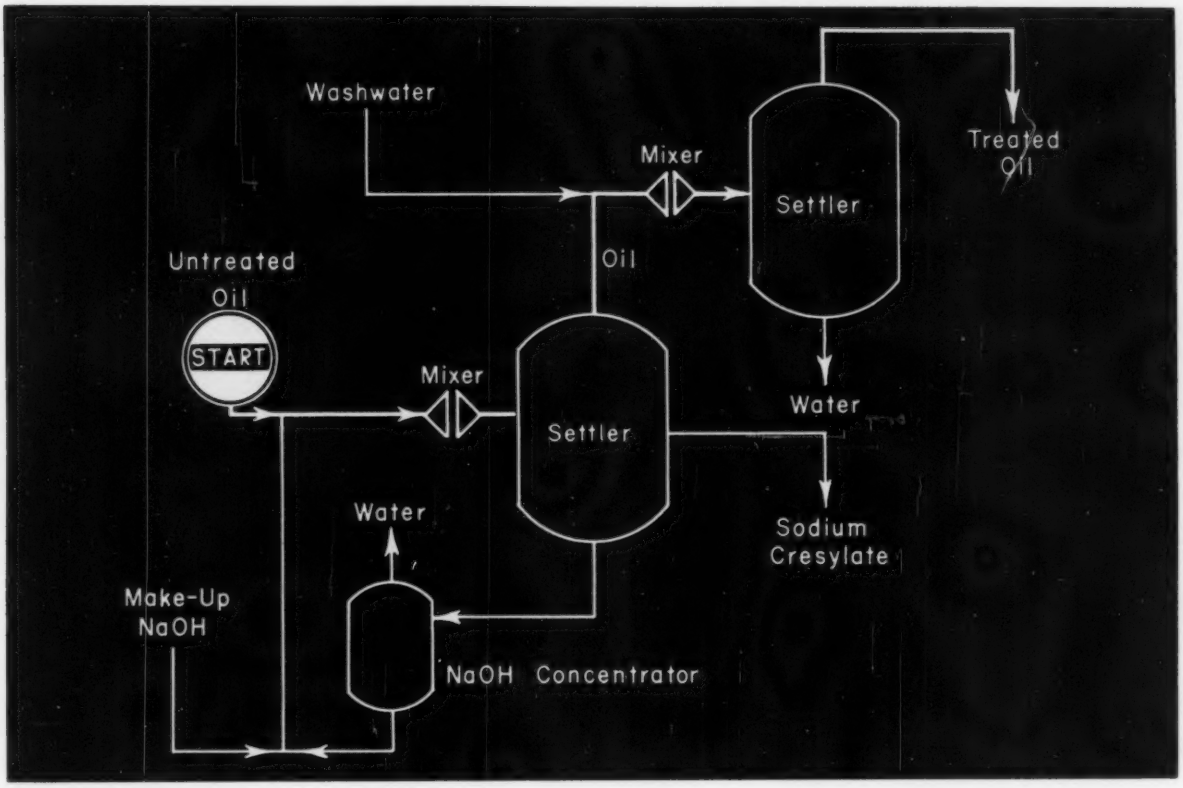
The hydrocarbon stream leaving this separator is combined with second stage doctor solution and mixed in the No. 2 doctor mixer, and then enters the No. 2 doctor separator where most of the doctor solution and lead sulfide formed in the sweetening reaction settle out.

The sweetened stock leaving the No. 2 separator is cooled in the product cooler and passes through the coalescer where residual doctor solution and lead sulfide are removed. Doctor solution from the No. 1 separator is normally circulated through the doctor heater and regenerator, combined with the regeneration air, and delivered back to the No. 1 mixer.

Doctor solution from the No. 2 doctor separator is normally returned directly to the No. 2 mixer. Periodically this solution is pumped forward to the No. 1 mixer and replaced with fresh doctor solution from storage. When this is done an equal volume of spent solution from the No. 1 separator is discarded.

Doctor solution is continuously circulated from the bottom of the regenerator to a nozzle located in the side of the regenerator by means of the doctor pump. This circulation prevents lead sulfide from settling out in the regenerator.

Reference: PETROLEUM REFINER 30, No. 1, 138 (1951).



Dualayer Distillate Process— SOCONY MOBIL OIL COMPANY, INC.

Application: To reduce sulfur content and improve color, odor, oxidation stability and inhibitor response of distillate fuel oils and similar products. The carbon residue, sediment and metals content and the tendency to form cloud in storage are lowered. These improvements are obtained by removing from the oil less than 1 percent of the highly objectionable materials like mercaptans and oxygenated compounds. The cracked distillates treated by this process become compatible with the straight-run distillates.

Description: Fuel distillate charge is mixed with concentrated caustic solution and passed into an electrical precipitator settling vessel where three layers are formed. The upper layer is treated oil, the middle layer contains the impurities combined with caustic and the lower layer is the unspent caustic.

Treated oil is washed with water and pumped to storage. The middle layer consisting of organic salts is withdrawn from the system. The lower layer, along with fresh caustic make-up, is recirculated through the unit. Traces of water produced by the chemical reactions are removed by passing a portion of the caustic solution through a small vacuum concentrator.

Operating Conditions: Typical operating conditions for the unit are shown in the following table.

Oil Rate, bpd	15,000
Temperature Inlet Oil, °F.	130
Caustic Treat	
Dosage, volume percent of oil	5
Mixer Pressure Drop, psi	15
Solution Strength, wt. % of NaOH	42
Water Wash	
Dosage, volume percent of oil	10
Mixer Pressure Drop, psi	25

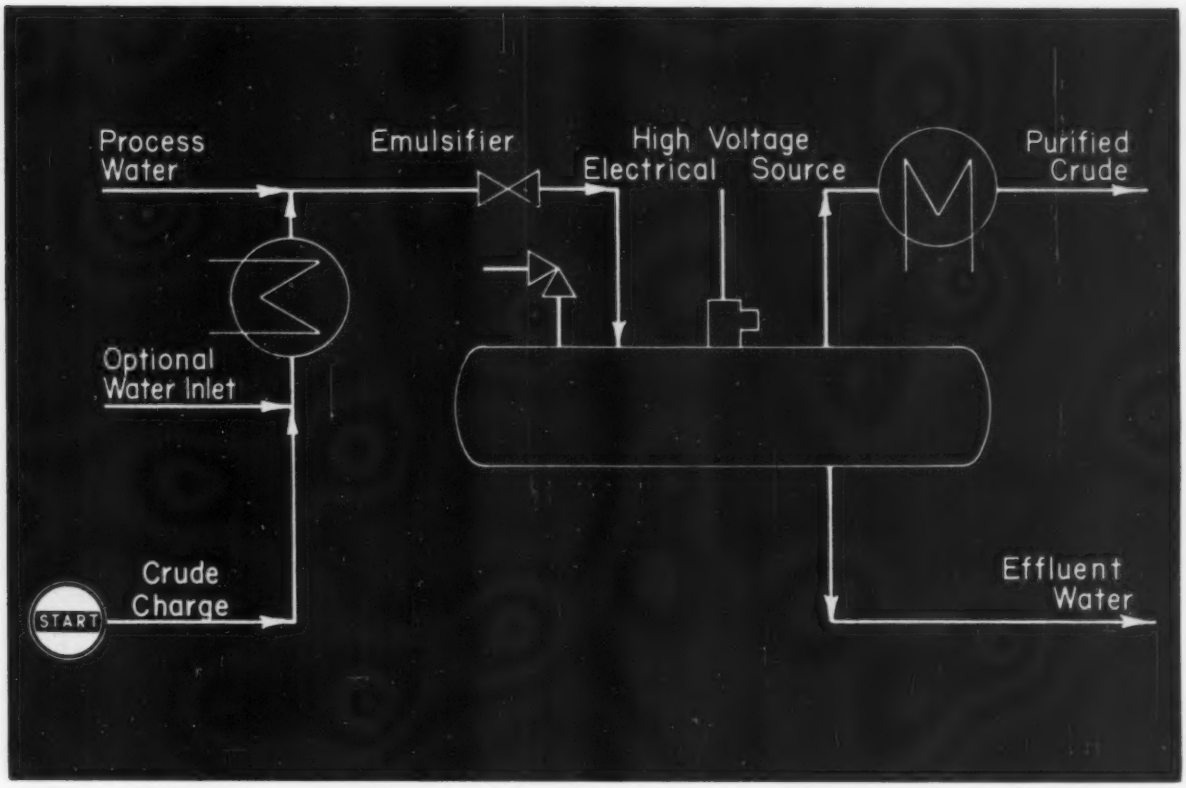
Yields: Charge and products properties of a typical cracked fuel oil distillate are shown in the following table.

Properties	Untreated	Treated
Gravity, °API	27	27
Color, ASTM	1½	1½
Mercaptan Sulfur, wt %	0.01	0.001
Carbon Residue,[1] wt %	0.10	0.07
After One Year Storage Equivalent[2]		
Carbon Residue,[1] wt %	0.49	0.21
Color, ASTM	8	4
Sediment, mgs./100 ml	17.3	2.5

[1] On 10% bottoms
[2] Based on Gulf Coast temperatures

Commercial Installations: These include two 15,000-barrel units at Beaumont, Texas, and a 9,000-barrel unit at Brooklyn, New York.

Reference: PETROLEUM REFINER 34, No. 9, 142 (1955).



Electric Desalting — PETROLITE CORPORATION

Application: Pre-refining purification of crude oils used as refinery charging stock. Removes salts, sediment and other impurities by means of electric precipitation.

Charge: Any crude oil used as a refinery charging stock.

Products: A purified crude charge in which salts such as chlorides, sulfates, and bicarbonates, and solids such as sand, silt and rust particles are reduced to such a degree that refinery operations are unhampered. Arsenic also is substantially reduced.

Description: In the refinery, the Petreco Desalter is an integral unit in the flow plan. In operation, charging crude from refinery storage is pumped into the Petreco unit after first passing through a primary heat source. After heating, the crude is mixed under controlled conditions, with a small quantity of fresh water to form a water-in-oil emulsion. The emulsion then is dispersed into a high potential electrostatic field in the treating section. The powerful coalescing forces of the electrostatic field cause the impurities (salts, solids, etc.) to be intimately associated with the fresh water. As this association is accomplished, the water, now serving as a carrier for the impurities, is separated rapidly from the oil and withdrawn. The purified crude oil continues on in normal refinery flow.

Three vessel types available are designated as Cylectric, Electrosphere and Vertelectric. Space requirements are nominal, depending on the type of Petreco unit installed, varying approximately from 150 to 1500 square feet.

Cylectric desalters are cylindrical, set in a horizontal position. They usually are 10 to 12 feet in diameter, the length varying according to treating capacity desired. Cylectric units are ideal for throughputs in the 10,000 to 100,000 barrels per day range, and are especially suitable where high operating pressures are desirable.

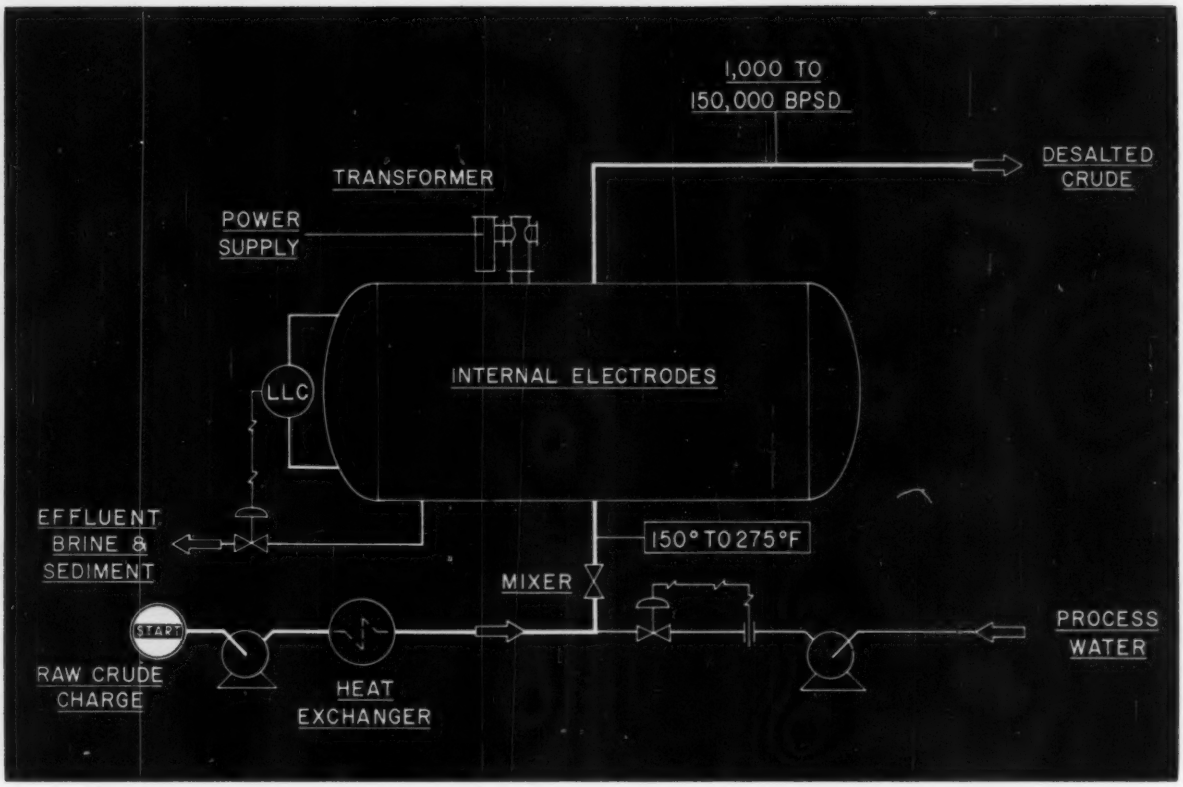
Electrospheres range in diameter from 12.5 to 36 feet. They have high throughput capacities, yet occupy minimum ground space. Individual Electrospheres currently are desalting up to 125,000 bpd.

Vertelectric desalters are cylindrical, set in vertical position. They are 10 feet in diameter, by about 15 feet overall in height, with a volumetric capacity of approximately 180 barrels. Treating capacities vary from 2,000 to 5,000 bpd. Vertelectric desalters are designed to handle the desalting requirements of small refiineries.

Operating Conditions: Normal operating temperatures are in the 180°-300° F. range; optimum temperature depends on the crude. Operating pressures vary according to the type of unit used, and are in the 50 to 300 psi range. The oil-water level, rate of flow, rate of disposal and power supply are automatically regulated by pre-set controls.

Commercial Installations: There are over 250 streams being desalted in North America and abroad.

Reference: PETROLEUM REFINER, 32, No. 9, 125 (1953).



Electrical Desalting— HOWE-BAKER ENGINEERS, INC.

Application: To remove salts and other impurities.

Charge: Crude oil.

Description: Fresh water is added to the raw crude at the rate of 4 to 8 volume percent of the oil rate to dissolve and absorb impurities. This water is mixed under controlled conditions with the crude to form a stable emulsion. The water-in-oil emulsion thus formed is resolved by introducing it into a high voltage electrostatic field inside the vessel. The action of this field is to agglomerate the dispersed water phase and force it to accumulate in the lower portion of the drum. The water which contains the various impurities removed from the crude is continuously discharged to the effluent system.

Clean desalted crude flows from the top of the vessel to the refinery flow circuit.

Provision is made for injecting small quantities of demulsifying chemical. Although not continuously required for all types of crudes, it provides flexibility so that tank bottoms, slop oils and oils with abnormally high suspended solids can be processed with maximum efficiency.

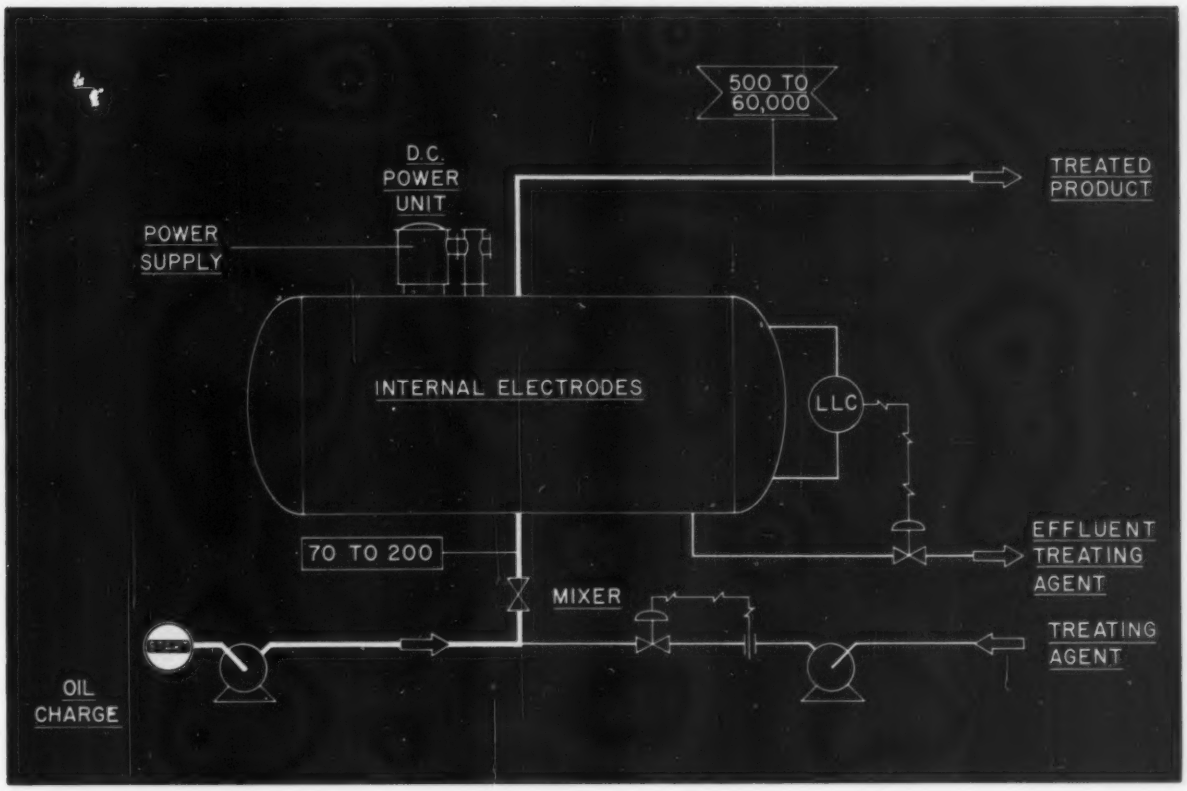
Salts in oil are most generally contained in residual water in the crude oil. Chemical composition of these salts varies widely with the major portion being sodium chlorides and less amounts of calcium and magnesium chlorides.

All crude oils also contain as mechanical suspensions certain solid materials such as silt, iron oxides, silica or quartz sand, crystalline salt, carbon and sulfur. Since many of these suspended impurities will be carried in or on water globules, a great proportion of them will be removed during the desalting process.

Advantages of electrical desalting include: Low operating costs, consistent operation under abnormal feedstock conditions, high capacity, and low residual salt levels.

Operating Conditions: Depending on the characteristics of the crude being treated, temperatures required at the desalters will be in a range of 150° to 275° F. A minimum operating pressure of 40 psi is required. Higher operating pressures do not affect the process and the upper limits may be established by design requirements of other elements in the flow circuits. Several plants have been installed for operating in a range of 325 to 350 psi. Savings in installation costs may be realized by using higher pressure designs in order to eliminate surge vessels and booster pumps after the desalter.

Commercial Installations: Howe-Baker desalters now in commercial use have a design capacity of over 3.4 million barrels per day. A partial list is as follows: The Atlantic Refining Company, 82,000; California Oil Company, 65,000; Esso Standard Oil Company, 336,000; Humble Oil & Refining Company, 280,000; Imperial Oil Company, Ltd., 63,000; Lago Oil and Transport Company, 344,000; The Pure Oil Company, 104,000; Petroleos Mexicanos, 142,000; Shell Oil Company, 92,000; Socony Mobil Oil Company, 179,000; Sinclair Refining Company, 315,000; Standard Oil Company (Texas), 25,000; Sun Oil Company, 63,000; Texaco Inc., 203,000; and others not listed, 1,127,000.



Electrical Distillate Treating—HOWE-BAKER ENGINEERS, INC.

Application: Treating of most distillates, from naphtha to lube oil boiling ranges, with treating agents such as caustic, acid or water.

Charge: Petroleum distillates.

Description: Electrical precipitation is a new means of implementing existing treating techniques with extremely high efficiency. A high voltage direct current electrical field is used to continuously break emulsions formed by treating agent and hydrocarbon. This makes possible higher mixing levels and better utilization of treating agent.

A typical example is the treatment of virgin heating oil with 15° Baumé caustic. Caustic is pumped into the heating oil stream and the two are intimately mixed. The emulsion formed goes to the treating vessel where it flows through the high voltage electrical field. The caustic is broken out of the emulsion and falls to the bottom of the vessel where it is continuously withdrawn. The treated heating oil flows out the top of the vessel directly to product storage. Sodium carryover in the oil, as NaOH, is less than 2 ppm. The oil is bright and haze-free.

Such an installation would eliminate the need for water washing, salt drying, air blowing or clay filtering steps, and would result in substantial savings.

This is but one example of the infinite variety of feedstock and treating agents which can be handled.

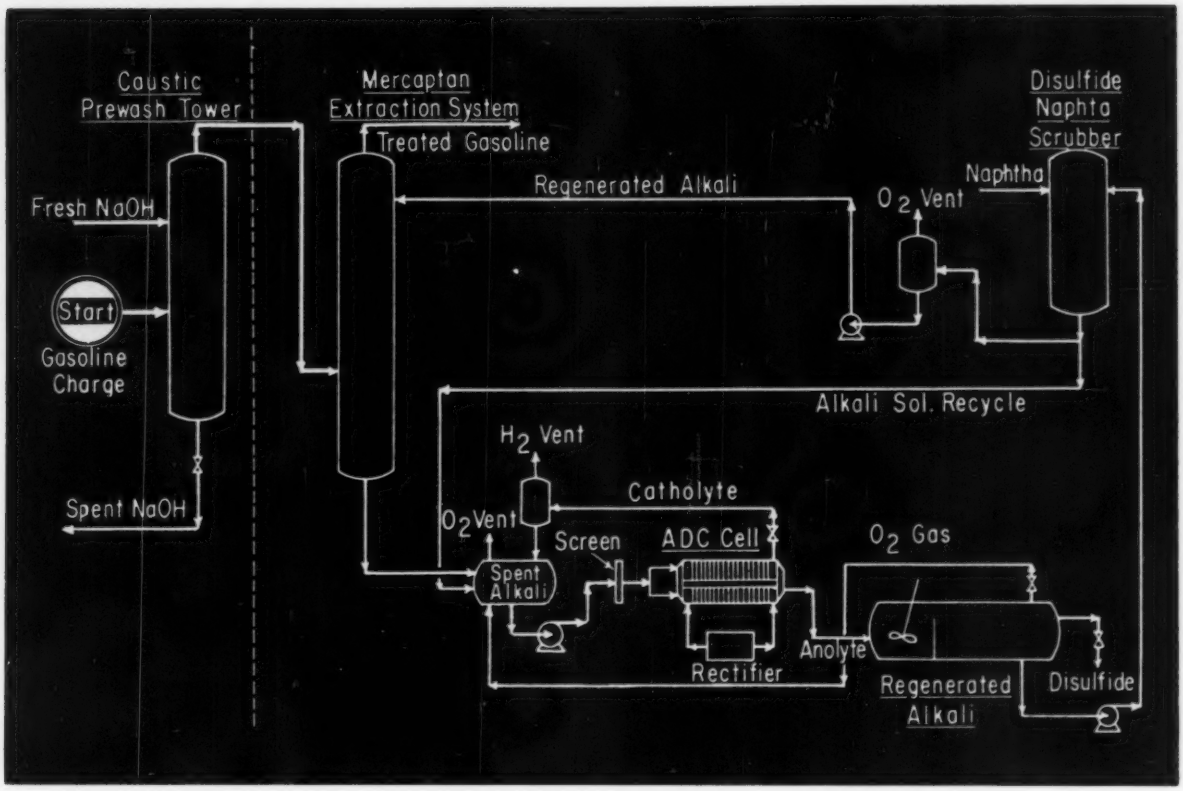
Typical treating results are shown in the accompanying table.

Operating Conditions: Flexibility is such that operating conditions may be varied over a wide range. Temperature normally falls in the range of 80°-150° F. Very viscous stocks, such as lubes, may require higher temperatures. Operating pressure is normally in the range of 30-300 psig. Lower limit is set by vapor pressure of feedstock, and there is no upper limit except for economy of vessel cost.

Commercial Installations: Units in operation or under construction have a design capacity of over 1,500,000 bpd. A partial list of purchasers of these units follows: The Atlantic Refining Company, Cities Service Refining Corporation, Esso Standard Oil, Humble Oil & Refining Company, Mobil Oil Francaise, Socony-Vacuum Oil Company, The Carter Oil Company, Commonwealth Oil Refining Company, Lago Oil and Transport Company, and Standard Oil Company (California).

Reference: PETROLEUM REFINER 38, No. 2, 151 (1959).

Feed Stock	Treated With	Carryover
Catalytic Heater Oil	4% of 25 Be′ NaOH	2.6 ppm sodium as NaOH
Catalytic Heater Oil	4% of 50 Be′ NaOH	9.7 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Virgin Heater Oil	2% of 10 Be′ NaOH	1.2 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Kerosine (Paraffinic)	10% of 15 Be′ NaOH	0.6 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Kerosine (Naphthenic)	10% of 15 Be′ NaOH	0.4 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Light Naphtha	7% of 15 Be′ NaOH	0.3 ppm sodium as NaOH
Gasoline, Straight Run	7% KOH	0.47 ppm KOH
Gasoline, Cat. and Virgin Mixture	10% of 50 Be′ NaOH	7.8 ppm sodium as NaOH
Gasoline, Cat. and Virgin Mixture	10% of 30 Be′ NaOH	2.9 ppm sodium as NaOH
Lube Oils:		
50 ssu @ 100° F.	20 volume % H_2SO_4	0.15 volume % sludge
100 ssu @ 100° F.	10 volume % H_2SO_4	0.2 volume % sludge
450 ssu @ 100° F.	7 volume % H_2SO_4	0.2 volume % sludge
750 ssu @ 100° F.	12 volume % H_2SO_4	0.3 volume % sludge



Electrolytic Mercaptan— AMERICAN DEVELOPMENT CORPORATION

Application: For reducing mercaptan content to improve odor and lead susceptibility.

Charge: Any hydrocarbon mixture in which the mercaptan content is objectionable.

Description: The stock, if is contains acid substances, such as H_2S and acid oils, is given a preliminary caustic wash. The pretreated gasoline is then contacted with an aqueous alkaline solution—usually NaOH or KOH—in a continuous counter-current system for mercaptan extraction. The mercaptan-rich alkaline solution flows into the spent alkali surge drum where it is mixed with partially regenerated solution and oxygen gas and then pumped to the electrolytic cell.

In the anode compartments of the cell, mercaptides are converted to disulfides with some excess of oxygen which later leaves the cell with the anolyte and is then immediately mixed in a turbo-mixer or similar device to convert additional mercaptides to disulfides. The dispersed mixture of alkali and oxygen is permitted to settle; the disulfides being substantially insoluble in the alkaline solution form an upper layer in the settler and are periodically drawn off. The regenerated caustic from the settler is given a naphtha or butane wash to remove unseparated disulfides. Part of the alkaline solution is recycled to the spent alkaline tank; the remainder is pumped to the extraction system for further service.

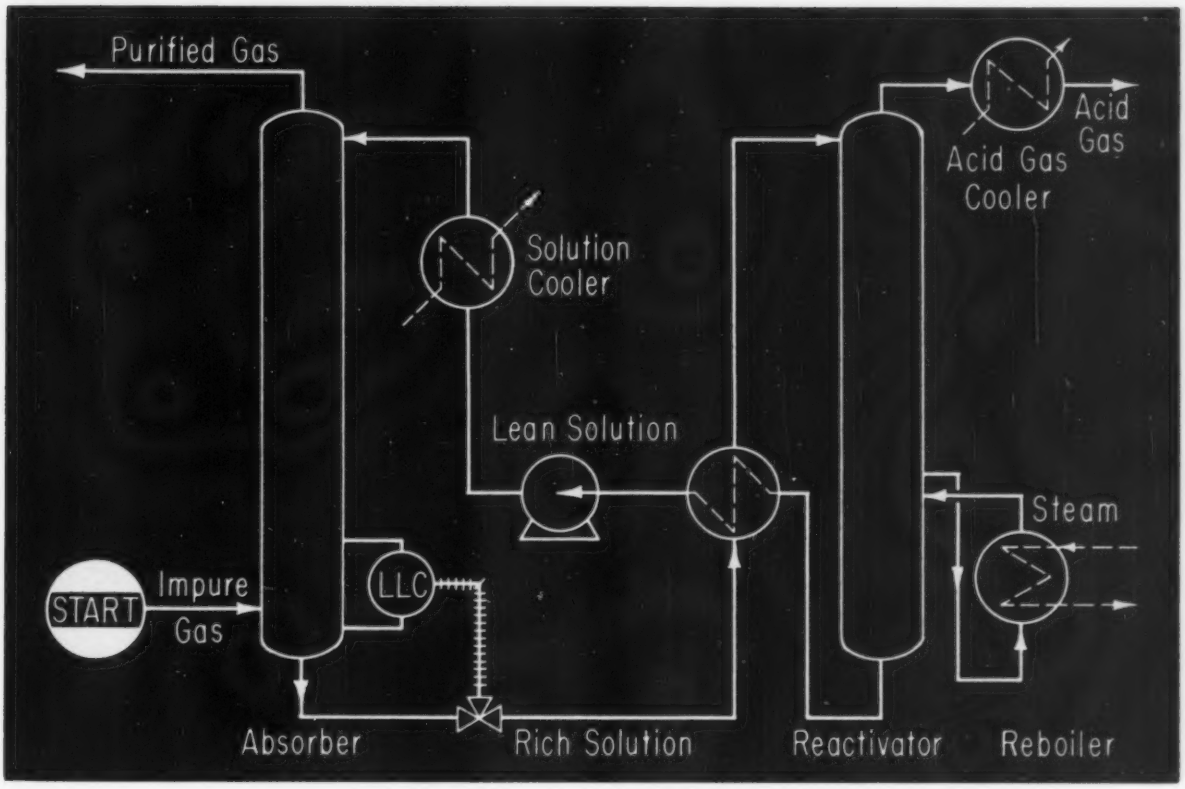
The electrolytic cell is of special design with filter press plates and permeable diaphragms. The rectifier is of the conventional type.

The process normally operates at ambient temperatures and neither heating nor cooling is required. With adequate pretreatment no chemicals are consumed.

Economics: The electrolytic equipment costs between $4,000 and $5,000 per 100 pounds daily capacity for mercaptan sulfur conversion. Operating costs are relatively low—the power cost (at 1c kwh) for converting 500 pounds per day of mercaptan sulfur is approximately $30.

Commercial Installations: The first unit was installed at Ashland, Ky., during 1951. Capacity—5,000 bpd. Additional units have been installed at Raffineries Francaises de Petrol de L'Atlantique, Donges, France—6,500 bpd; Leonard Refineries, Alma, Mich.—5,000 bpd; Sun Oil Company, Sarnia, Ontario—2,000 bpd; Arabian American Oil Company, Ras Tanura, Saudi Arabia—25,000 bpd.

Reference: PETROLEUM REFINER 33, No. 11, 205 (1954).



Girbotol—GIRDLER CORPORATION

Application: The process is employed for removal and recovery of hydrogen sulfide and carbon dioxide from natural and refinery gases, for purification of liquid hydrocarbons, and for separation of carbon dioxide from hydrogen and synthesis gases.

Description: The Girbotol process originated with the discovery that acidic gases such as hydrogen sulfide and carbon dioxide react with certain amines to form compounds which may be broken down by heat. This reversible reaction may, in the case of hydrogen sulfide, be represented as follows:

$$RNH_2 + H_2S = RNH_2HS$$ (where R represents an organic radical)

The equilibrium proceeds to the right or left, depending on the temperature, and on the partial pressure of the hydrogen sulfide. The solutions generally employed are aqueous solutions of ethanolamines, mono-(MEA), di-(DEA) or tri-(TEA).

The operation is a continuous process in which the solution passes through the absorber where hydrogen sulfide is removed from the gas, through a heat exchanger and into the reactivator. In the reactivator hydrogen sulfide is stripped from the rich solution by heat and passes out of the tower as a concentrated gas together with some steam into the acid gas cooler. The steam is condensed in this cooler and returned to the cycle while the hydrogen sulfide may be flared, burned under a boiler or recovered as elemental sulfur.

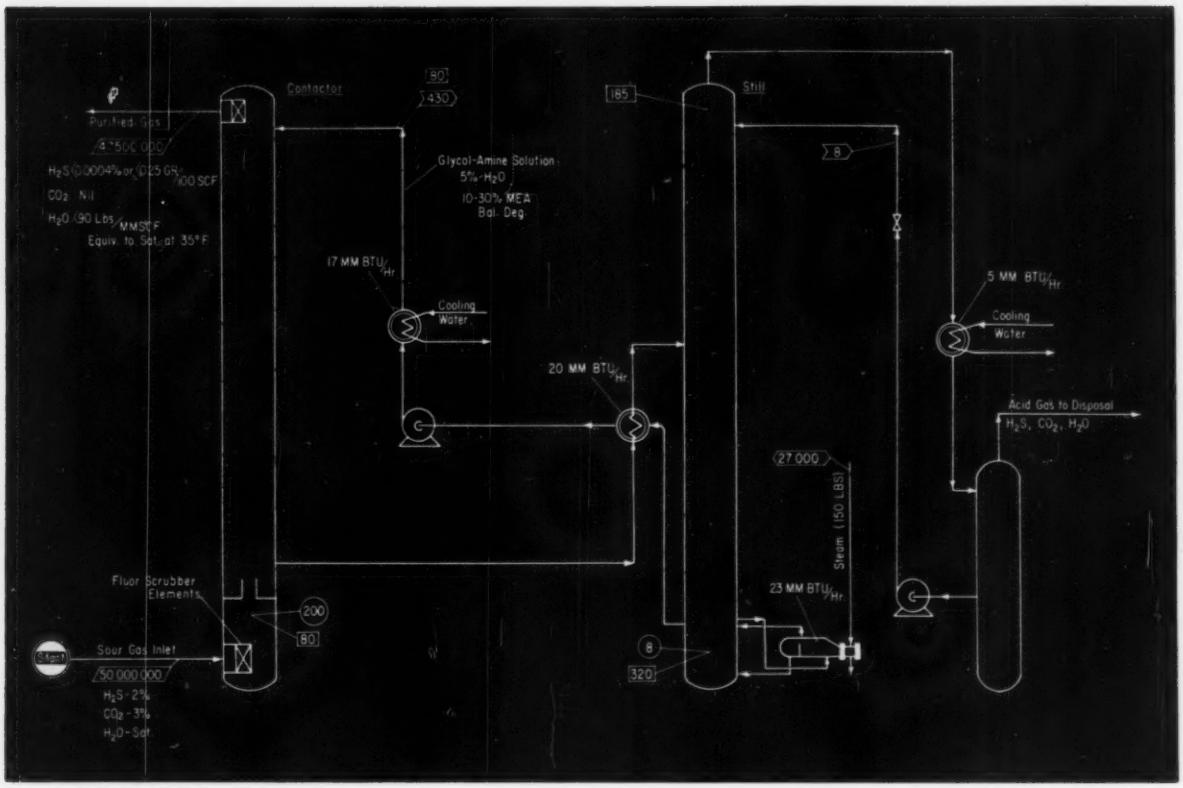
The lean solution, essentially free from acid gases, passes from the bottom of the reactivator through the other side of the heat exchanger, a circulating pump, a solution cooler and back to the absorber. The case shown is typical for high pressure natural gas operation. The absorber and reactivator towers may be either packed or bubble plate towers of conventional design.

Another application for the Girbotol process is in use for purifying liquid hydrocarbons in a similar manner. A packed or sieve plate tower is used for the absorber and either the liquid hydrocarbon or the Girbotol solution maintained in a continuous phase depending on the specific case.

Operating Conditions: The choice of the proper amine and solution strength depends on the composition of the gas to be treated, the percentage of hydrogen sulfide and/or carbon dioxide in the gas and final purity desired. In many cases it is possible to attain a moderate degree of selectivity by the proper choice of solutions and operating conditions where complete hydrogen sulfide removal is desired and carbon dioxide removal is not required. The solution circulation rate of a Girbotol plant depends on the above factors as well as on the quantity, temperature and pressure of the gas to be treated. If the gas mixture is at its hydrocarbon dewpoint, the treating temperature should be maintained 10° to 20° F. above the inlet gas temperature to prevent the condensation of hydrocarbons in the treating equipment. Girbotol plants are customarily designed to purify gases at their full line pressure and the pressure drop through the equipment ordinarily will not exceed 5 to 10 psi.

Commercial Installations: Several hundred.

Reference: *Petroleum Engineer* 26, No. 10, C-57 (1954).



Glycol-Amine Gas Treating— THE FLUOR CORPORATION, LTD.

Application: For the simultaneous removal of water vapor, H_2S, and CO_2 from gas streams. The solution normally used is an aqueous mixture of monoethanolamine (MEA) and di- or triethylene glycol. By replacing the MEA with methyldiethanolamine, this process may be adapted to remove water vapor and hydrogen sulfide from gas streams, with only partial removal of CO_2.

Product: Sour gas streams may be purified to contain a guaranteed maximum of 0.15 grain H_2S/100 scf, and a few parts per million CO_2. The gas is dehydrated to a dew point equal to that obtainable with a straight glycol system.

Description: As shown in the typical flow diagram, the gas is purified and dehydrated in a conventional countercurrent absorption system employing bubble-cap tray columns. The solution passing downward through the contactor absorbs the water vapor and acid gases from the gas. The purified gas leaves the top of the column.

The rich solution from the bottom of the cantactor is heated by interchange with hot solution from the still, and flows into the regenerating column. Here it is stripped of the water vapor and acid gases by reboiled vapors. The overhead stream of acid gas and water vapor passes into a condenser-accumulator for recovery of the water content, which is returned to the still as reflux.

The regenerated solution passes from the bottom of the still through the interchangers mentioned earlier, and is pumped through water cooled exchangers to the top of the contactor.

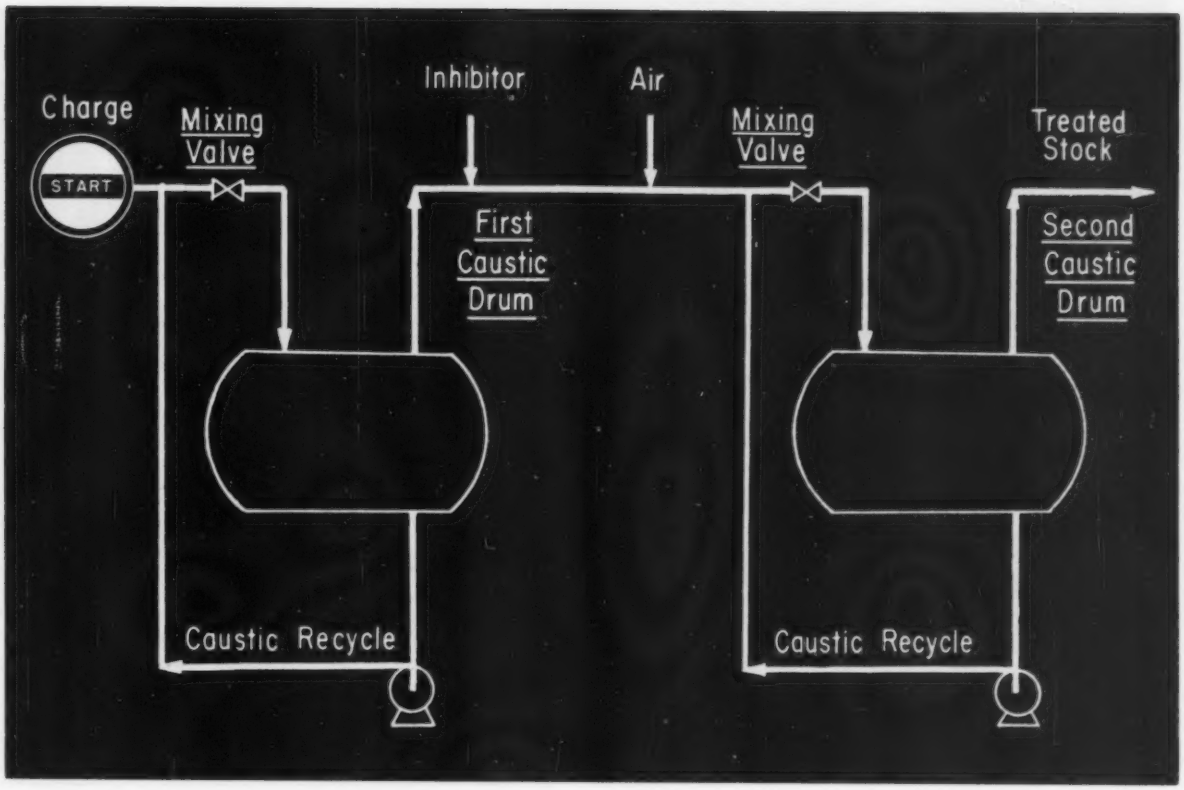
Typical solutions used in the process are comprised of 10-30 weight percent monethanolamine, 45-85 percent glycol and 5-25 percent water. The ability to adjust components of the solution makes it possible to economically meet a wide range of specifications for acid gas purity and water content.

In addition to simultaneous purification and dehydration, which results in a low initial investment and operating cost for the combined treating operation, other advantages resulting from the use of the glycol-amine solutions are reduced corrosion and more satisfactory operation with regard to foaming.

Yields: In a typical installation, treating approximately 60 MMscfd gas containing 450 grains H_2S per 100 scf, the treated gas contained less than 0.5 grains H_2S per 100 scf.

Commercial Installations: The total installed capacity of glycol-amine plants is in excess of one and one-quarter billion standard cubic feet per day.

Reference: PETROLEUM REFINER 32, No. 9, 124 (1953).



Inhibitor Sweetening

Application: To reduce the mercaptan concentration of refinery products.

Charge: Usually gasoline having only moderate initial concentration of mercaptans.

Product: A stock containing less mercaptans to the point that they can be "doctor sweet" after a short storage time.

Description: This sweetening technique is based on the principle of oxidizing mercaptans to disulfides. A caustic solution and a substituted phenylene diamine type of inhibitor act as catalysts. Air furnishes the oxygen for the oxidation reaction.

The charge first is given a caustic wash to reduce the initial concentration of mercaptans. A recirculating caustic wash can be used. It consists of a mixing valve to achieve contacting of the caustic solution with the charge, a settling drum to permit the separation of the caustic from the main stream, and a pump to recirculate the caustic solution.

The caustic solution can be 10-30 weight percent strength and can be regenerated by air and steam blowing. If a nonregenerative system is used, the caustic is dumped periodically when the buildup of sodium mercaptide hampers further mercaptan extraction.

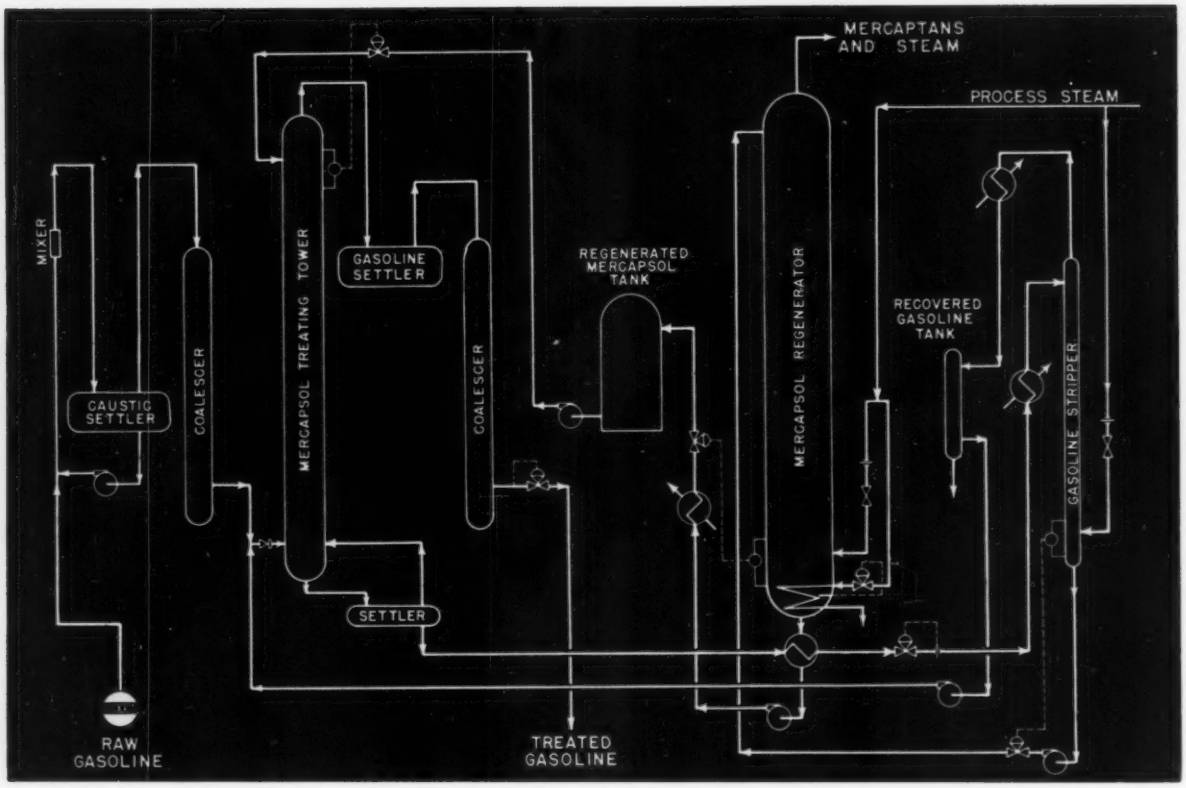
After the charge is caustic washed, inhibitor and air are added. In addition to its sweetening property, the diamine type of inhibitor has the property of retarding the formation of gum. Thus the inhibitor usually is added upstream of the air addition point. There it protects the charge against the possible gum forming side-reactions promoted by air.

A second caustic wash is employed to furnish the alkaline environment needed for the mercaptan oxidation reactions. The second caustic wash system can be similar in equipment and operation to the first wash system.

Although the oxidation of mercaptans to disulfides can take several hours or even days, a "doctor sweet" specification usually is achieved before the stocks find their way into a finished gasoline blend. The presence of the inhibitor in these stocks reduces the amount of the oxidation inhibitor normally added to the finished gasoline blends.

Economics: Existing caustic washing facilities can be converted to inhibitor sweetening with very minor alterations. Addition points for the inhibitor and air are usually all that are required.

Reference: *Petroleum Processing* 6, p. 969 (1951).



Mercapsol — THE PURE OIL COMPANY

Application: Removes mercaptan sulfur compounds from gasoline, thereby providing a method for meeting sulfur and odor specifications and for improving the lead susceptibility.

Charge: Straightrun, thermally cracked or thermally reformed gasolines which are frequently very difficult to treat by other methods.

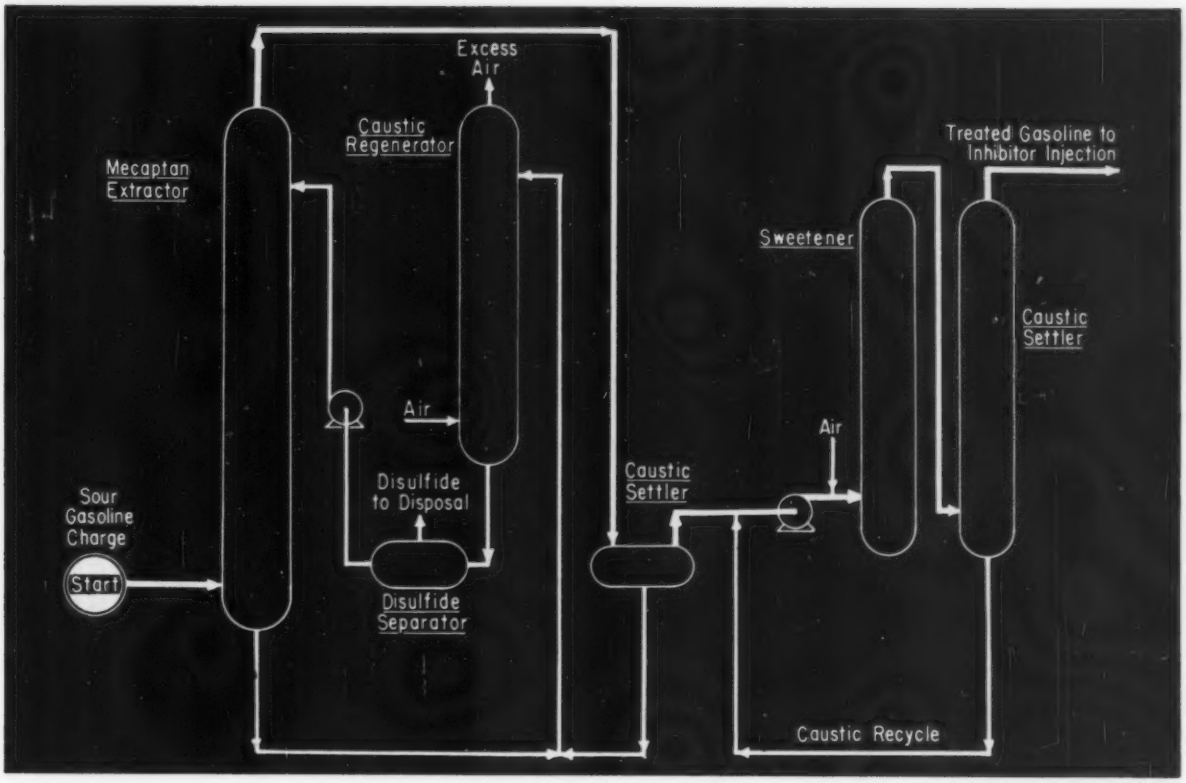
Product: In most cases a reduction in mercaptan sulfur content of 95 to 99 percent can be accomplished conveniently, and many gasolines can be extracted to doctor sweetness directly. In almost any case the use of a suitable gum inhibitor after Mercapsol treating will result in a doctor sweet product. Since mercaptans are actually removed from the gasoline instead of being converted to disulfides or other sulfur compounds, the product contains less total sulfur than the charge, and the process thus aids very materially in meeting sulfur specifications. One of the principal advantages of the process is an improvement in the tetraethyl lead susceptibility of the gasoline. An improved gum inhibitor susceptibility is an additional benefit.

Description: The operation of the process is illustrated by the flow diagram. Gasoline is treated in the liquid phase at ambient temperatures. Hydrogen sulfide and other acidic substances, which would otherwise build up in the permanent treating solution, are first removed by contact with low strength caustic solution. The gasoline from this step passes through a coalescer whose function is to remove any aqueous phase which would contain sodium sulfide and other salts. The gasoline then enters the treating tower near the bottom, where it is intimately contacted counter-currently by the descending continuous phase of Mercapsol solution which effectively extracts the mercaptans. From the top of the treating tower the treated gasoline flows through a settler and a coalescer for clarification and on to inhibiting and storage.

Spent Mercapsol solution containing the extracted mercaptans is withdrawn from the bottom of the treating tower into a settler from which the gasoline that separates can return by density difference to the tower. The treating solution as it then flows from the Mercapsol settler contains a small amount of dissolved gasoline which is recovered and returned to the treating tower. Recovery of the dissolved gasoline is accomplished in a small stripper by the use of a small amount of steam which is sufficient for this purpose but not enough to strip much of the mercaptan present. The Mercapsol is then steam stripped of mercaptans in the regenerating tower, and after cooling is stored in the regenerated Mercapsol tank from which it is pumped to the top of the treating tower to repeat the cycle.

The Mercapsol treating solution is an aqueous solution of sodium hydroxide containing salts of certain acid oils which act as solubility promoters for mercaptans. With proper precautions against contamination and loss the solution may be used indefinitely.

Reference: *The Oil and Gas Journal,* 42, No. 49, 126 (1944).



Merox — UNIVERSAL OIL PRODUCTS COMPANY

Application: For treating gasoline and lower boiling fractions for removal of mercaptans, or sweetening heavier stocks by converting mercaptans to disulfides.

Products: Products of reduced sulfur content when treated by extraction technique. Doctor sweet products when sweetening technique is used.

Description: Extraction and sweetening of a sour gasoline is used as a non-limiting example of a commercially operating unit; equipment is indicated in the flow diagram. Sour gasoline is contacted with caustic containing Merox catalyst to extract the mercaptans. The treated gasoline is settled, and then washed with more caustic containing Merox catalyst to convert higher molecular weight mercaptans to disulfides; air is injected with gasoline. Caustic entrained with the gasoline is returned from the settler to the sweetener.

Caustic used in the extraction section is regenerated by air blowing which converts the mercaptans (as sodium mercaptides) to disulfides. The disulfides are removed in another settler as the overhead product; the liquid regenerated Merox caustic, is returned to the extractor column.

Low molecular weight stocks need only extraction, as they contain no high molecular weight mercaptans. Other stocks, such as heavy cracked gasoline, kerosine and No. 2 fuel, are sweetened because the disulfides which remain in the treated stocks are not deleterious.

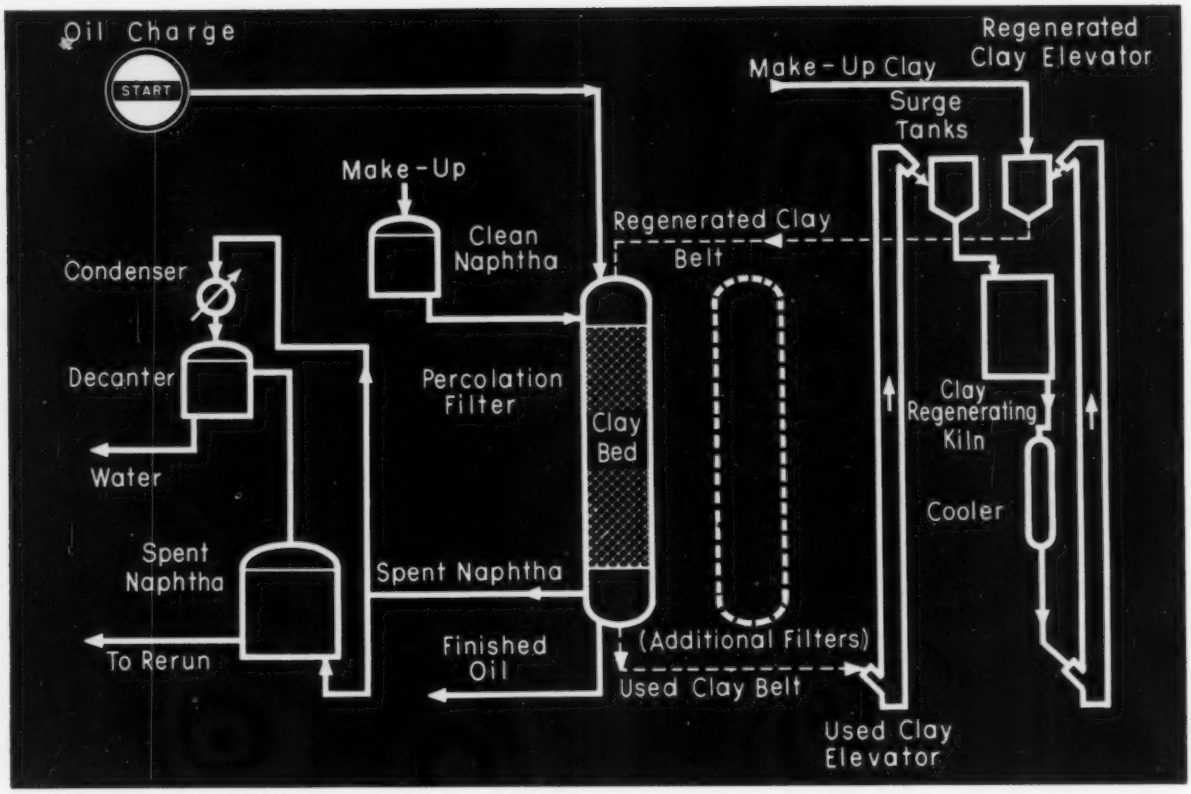
Product Quality and Economics: Commercial Merox treating is compared below with regenerative caustic and copper sweetening of the same stock, wherein existing facilities were converted to the Merox operation.

		Former Operation		Merox Process	
	Raw Gasoline	Mercaptan Extract. (Steam regen.)	Copper Sweet.	Mercaptan Extract.	Sweet.
Gasoline charged, bbl. per day	525	.....	.....	.....	.....
Mercaptan content, % S:					
Raw gasoline	0.06	.....	.....	.....	.....
After mercaptan extr.	.....	0.017–0.024	.....	0.011–0.017	.....
After sweetener	.....	.....	Swt.	.....	Swt.
Regenerated caustic	.....	0.25 –0.35	.....	0.02	.....
Operating Cost comparison:					
Power: same both cases					
Caustic consumption, ¢/bbl.	.....	Equal	None	Equal	0.12
Catalyst, ¢/bbl.	.....	.....	2.58	0.05	0.06*
Air, ¢/bbl.	.....	.....	0.05	0.022†	.....
Steam, ¢/bbl.	.....	3.6	.....	.....	.....
Operating labor	.....	Equal	Equal	Equal	Equal
Maintenance labor (changing catalyst)	.....	.....	1.50	.....	.....
Total	.....	3.6	4.13	0.072	0.18
Combined cost–both operations:		7.73		0.252	
Savings to refinery by Merox, ¢/bbl. (exclusive of royalty)		7.48			

* Initial charge plus weekly makeup of 25 to 50 g.
† Use of existing equipment (oversized for the new service) resulted in air use greatly in excess of requirements in properly sized equipment.

Commercial Application: Over 36 plants are in operation and many more are in design or construction stages. Capacities range from 250 to 12,000 bpsd.

Reference: Brown, K. M., Gleim, W. K. T., and Urban, P., "Low Cost Way to Treat High-Mercaptan Gasoline," *Oil & Gas J.* 57, No. 44 p. 73 (1959).



Percolation Filtration — MINERALS & CHEMICALS — PHILIPP CORP.

Application: For finish refining of lube oils and other fractions.

Product: Finished oils and waxes are characterized by excellent color, odor and taste, and by their stability in demulsifying properties.

Description: The process consists of filtering the oil or other charge through a vessel commonly containing 10 to 50 tons of adsorbent media, either fuller's earth or activated bauxite. After a preliminary period during which the clay bed is thoroughly soaked with charge oil, the latter is passed through the clay until the adsorbent fails to produce specification products. The first oil out is lightest in color. The color of the effluent oil darkens gradually as more and more oil flows through the unit. After the oil stream has stopped, naphtha is sent through the clay bed to reclaim the remaining oil. Steaming follows to recover the naphtha. The clay is then conveyed to a kiln for burning off the carbonaceous deposits of oil and impurities and returned to the filter for another cycle. The 20/60 and 30/60 mesh adsorbent grades have been found to be best adapted to most percolation refining operations.

The choice between activated bauxite and fuller's earth as the preferred percolation adsorbent is predicated on comparative costs and product quality considerations. Generally heavy decolorization requirements will favor fuller's earth while lighter color loads (less color reduction) will favor bauxite.

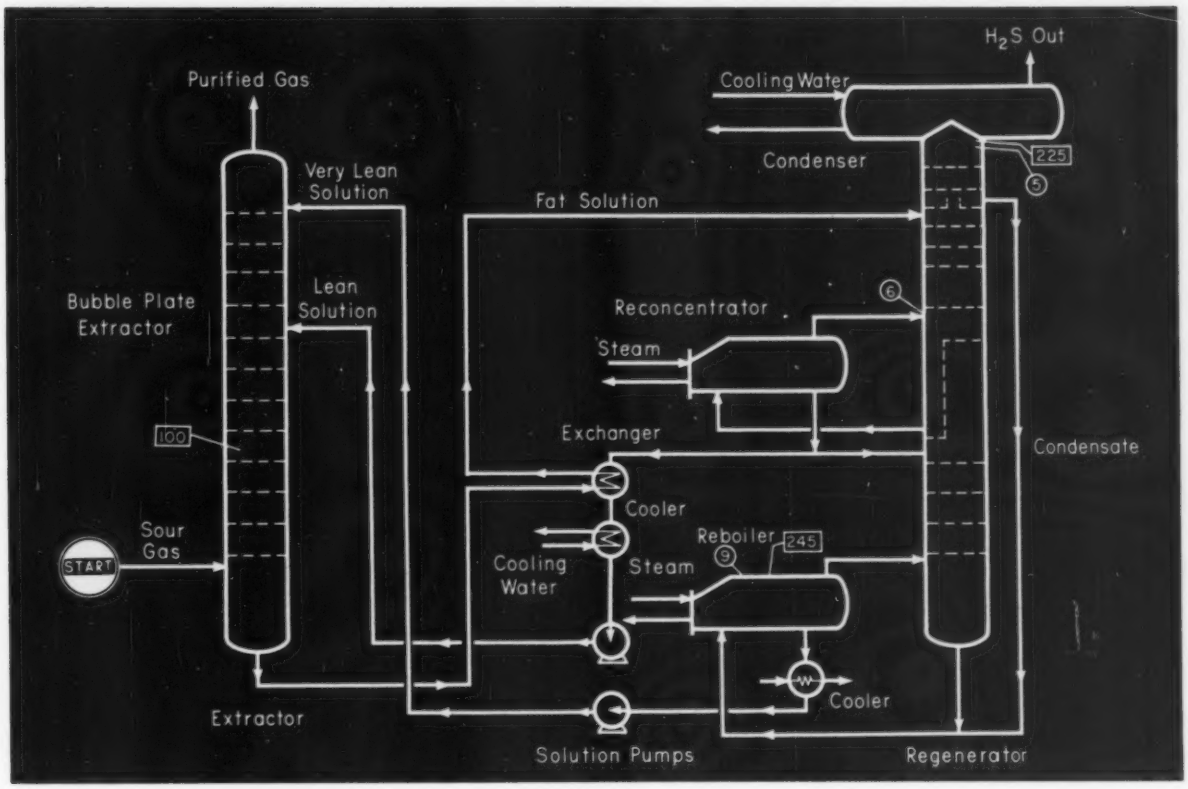
Yields: See table. The relative yields will vary with different oils, the principal factors influencing them being crude oil source and the amount of refining pre-treatment lubricating oil fractions received prior to filter finishing.

Commercial Installation: More than 53 installations.

References: *Petroleum Processing* 2, No. 9, 673 (1947).

CRUDE SOURCE	PROCESSING (A)	(B)	(C)	UNFILTERED OIL INSPECTION Gravity, API	Viscosity, S.U.S. 100 F.	210 F.	Viscosity Index	Pour Point, °F.	Color, NPA	PERCOLATION YIELD New Fuller's Earth Bbl./Ton	Bbl./MCF	New Bauxite Bbl./Ton	Bbl./MCF	Color, NPA
North Louisiana	....	P	MEK	28.0	207.0	46.5	92	—10	2—	77	1280	48	1360	1½
West Texas	....	D	MEK	32.7	208.8	47.4	103	— 5	1¼	257	4270	151	4270	1
Cal-Waxy	....	P	P	28.9	325.7	51.5	76	— 5	4 dil	84	1395	65	1840	2
Iraq	....	F	MEK	28.1	457.0	60.8	95	0	7¼	160	2650	130	3690	3
Oklahoma	....	F	MEK	29.1	511.6	62.6	90	0	4¼	52	865	114	3230	2
East Texas	Yes	D	MEK	27.7	1115.7	92.4	93	0	8	25	415	23	642	4
East Texas	Yes	P	MEK	27.4	1678.2	117.3	94	5	5¼	52	865	47	1330	5
West Texas	Yes	D	MEK	26.6	1618.3	119.3	99	5	7—	63	1045	60	1700	6

(A) Propane deasphalting. (B) Solvent extraction—P = Phenol, F = Furfural, D = Duosol. (C) Dewaxing—MEK = Methylethylketone—benzol, P = Propane.



Phosphate Desulfurization — SHELL DEVELOPMENT COMPANY

Application: For removing and recovering hydrogen sulfide from natural and refinery gases and liquid hydrocarbon fractions. The process consists of two steps: absorption and regeneration.

Description: The principal absorption reaction may be expressed by the equation:

$$K_3PO_4 + H_2S = K_2HPO_4 + KHS$$

Regeneration of the solution is effected by means of stripping steam, which reverses the absorption reaction.

Treatment of gas and liquid streams differs only in the design of the extractor and, generally, in the use of split-solution flow for gas treating. The sketch shows the split-solution flow scheme.

Under actual operating conditions, the tripotassium phosphate solution used in the process removes H_2S preferentially from gases containing both H_2S and CO_2. This unique feature of the Phosphate Process may be highly advantageous in desulfurization of natural or synthesis gases. In such cases it is often unnecessary or undesirable to remove most of the CO_2 along with H_2S for reasons besides the higher attendant stripping steam consumption.

The Phosphate process is particularly suitable for recovery of H_2S from which it is desired to make elemental sulfur. For that purpose it is important that the recovered H_2S be of high purity, i.e., with minimum CO_2 and hydrocarbon content. The Phosphate process can remove H_2S economically from gases containing CO_2 and H_2S in ratios as high as 20 to 1.

In treating gases, the extraction step is carried out in a bubble-tray column using split-solution flow. The raw gas is contacted countercurrently with the lean solution in the lower section of the column for removal of the bulk of the H_2S; as it proceeds through the upper part of the column, the gas is further contacted with the very lean solution to achieve the final degree of H_2S removal required.

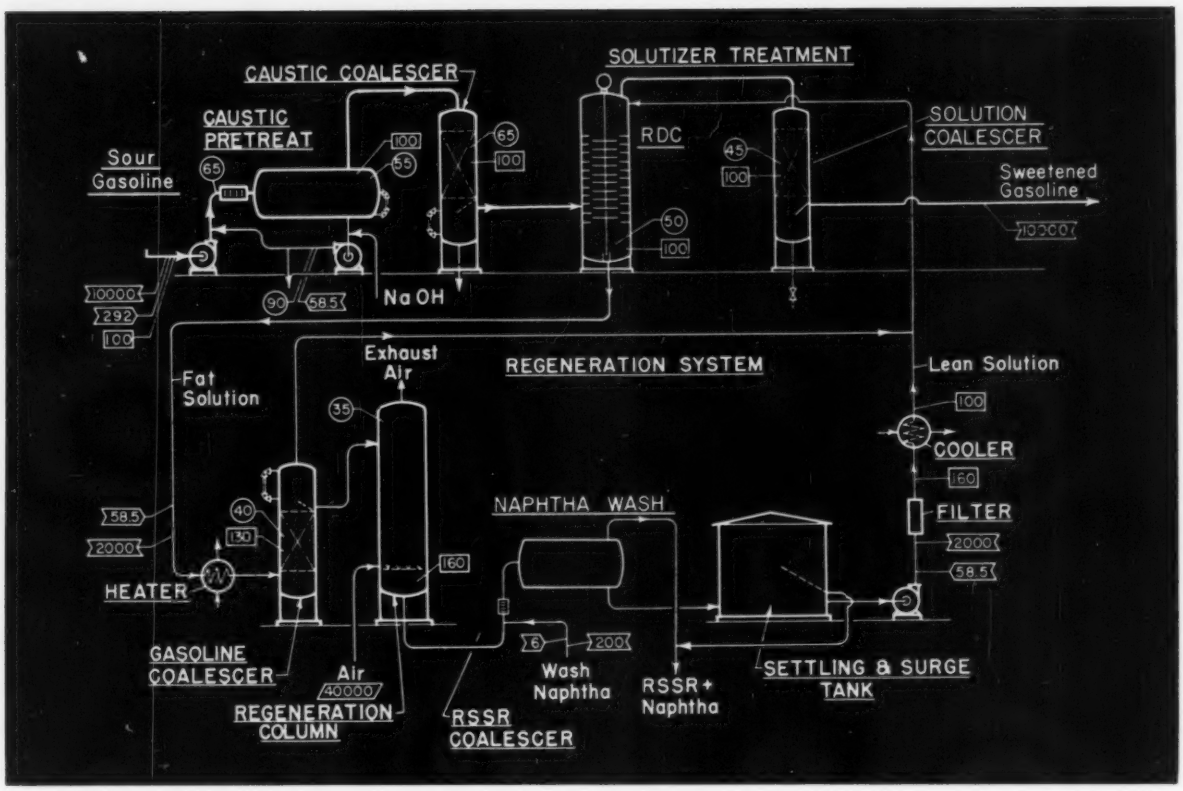
In the treatment of liquid hydrocarbon streams, the extraction step is achieved with countercurrent single-solution flow. After extraction, the liquid hydrocarbon flows through a solution coalescer which serves to safeguard against solution loss through entrainment.

The hydrogen sulfide recovered by this process is essentially free of hydrocarbons and is an ideal raw material for manufacture of sulfuric acid or elemental sulfur.

Since K_3PO_4 is a stable inorganic salt which does not decompose nor vaporize under treating conditions, it does not contaminate nor polymerize the hydrocarbons and the solution loss is negligible. Iron and steel are satisfactory for all equipment. If the cooling water is corrosive, admiralty-metal tubes and Muntz metal sheets and baffles may be used in the condenser and solution coolers. Gages, instruments, valves, and pumps should be all iron and steel. Observance of these general specifications will insure freedom from corrosion on the process side.

Commercial Installations: Forty plants have been installed.

Reference: PETROLEUM REFINER 29, No. 7, 107 (1950).



Solutizer— SHELL DEVELOPMENT COMPANY

Application: For removing mercaptans from sour gasolines.

Product: Mercaptan removal to the "odor sweet" level of 0.001 to 0.003 weight percent mercaptan sulfur is easily achieved when treating a wide range of straight-run or cracked stocks, either low-end-point or full-boiling-range gasolines.

Description: The three essential steps of the process are caustic pretreatment, solutizer treatment, and regeneration. Caustic pretreatment is often necessary to remove acidic component such as hydrogen sulfide and, in some cases, to control the alkyl phenol concentration. A single conventional mixer-settler arrangement is usually satisfactory for this purpose, and the caustic solution may be used until it is essentially saturated. A coalescer follows the caustic settler to minimize contamination of the potassium hydroxide treating solution with sodium ion.

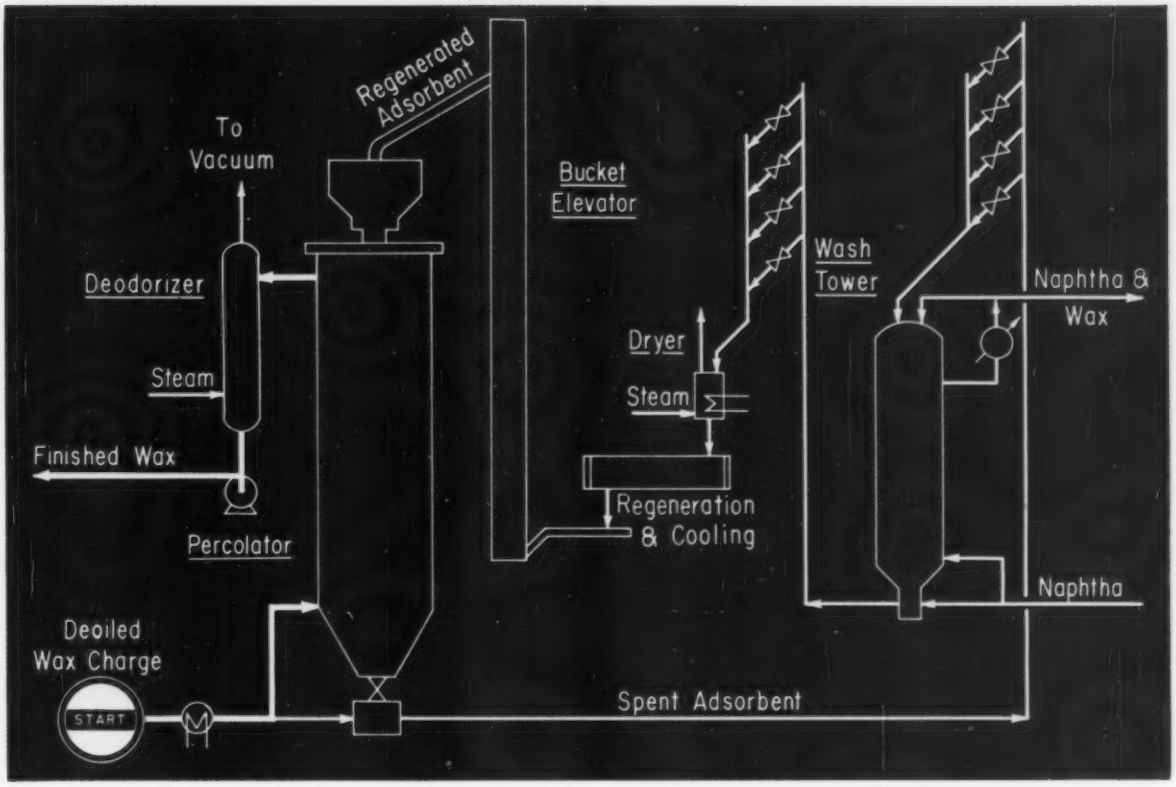
For mercaptan extraction the sour hydrocarbon feed is contacted with a suitable solutizer solution in countercurrent flow. The extracting agent is strong potassium hydroxide solution containing mercaptan solubility promoters (solutizers) such as fatty acids; e.g., propionic and butyric acids, and/or alkyl phenols. The latter may be used if their concentration in the fraction treated is great enough to maintain the required solutizer strength in the treating solution.

In the past, mixer-settler units have been used for the mercaptan extraction step. However, in all new designs, the Shell Rotating Disc Contactor (RDC) has replaced mixer-settlers. Use of the new apparatus in this step of the process substantially reduces capital cost and adds significantly to operating flexibility.

The treated hydrocarbon flows from the extraction section to storage or subsequent operations. The spent treating solution is heated to 130° to 160° F, passes through a gasoline coalescer, and enters the regenerator where the extracted mercaptans are oxidized to disulfides by air blowing. This operation is accomplished in a column equipped with efficient air dispersers or in any standard liquid-gas mixing device. Dissolved and/or entrained disulfide oil is removed by a naphtha wash. The naphtha required is only 1 to 2 percent of the gasoline treating rate, and it may be disposed of by adding it to reforming or catalytic cracking charge stock. The regenerated solutizer solution is then cooled and returned to the extraction step.

No corrosion-resistant metals are required since operating temperatures are low and the treating solution is noncorrosive. Labor costs are low due to the simplicity of operation and adaptability to virtually complete automaic control. The solution is inexpensive and has an extended treating life, so that chemical cost is nominal. Exhaust steam can be used to fulfill the limited heating requirements.

Reference: *The Science of Petroleum* 5, Part 2, 173 (1953).



Thermofor Continuous Percolation — SOCONY MOBIL OIL COMPANY, INC.

Application: To decolorize lubricating oils and waxes. Advantages over conventional processes include high adsorbent efficiency, low labor costs, and low investment and utility costs. The process can be used for countercurrent liquid-solid contacting whenever the solid has a greater density than the liquid.

Charge: Petroleum stocks percolated to date have ranged from lube distillates to microcrystalline waxes.

Products: Petroleum stocks can be decolorized and reduced in ultraviolet absorption index as completely as by the static process.

Description: The first units of this type had superimposed percolation and wash vessels. Development of a liquid "lift" system now allows these vessels to be located at grade, saving substantial structure costs.

Referring to the flow diagram, the regenerated adsorbent is introduced into the top of the percolator, where it flows down countercurrent to the charge, which is introduced at the bottom. The decolorized product flows from the top of the percolator to a vacuum "deodorizer" column. The spent adsorbent flows as a "slurry" to the wash column, where it is contacted by a countercurrent flow of naphtha to remove residual oil. The naphtha is fractionated to recover oil which is recycled to the percolator.

Washed adsorbent is "dried" in a heated vessel, purging with steam to remove naphtha. The dry adsorbent is then regenerated by some conventional method. The regenerated adsorbent is cooled and recycled to the percolator.

Operating Conditions: Conditions vary with the charge stock and degree of decolorization required.

Listed below are the conditions for decolorizing a paraffin wax fraction. Flow rates shown are based on 1,000 barrels per day of wax charge:

Adsorbent Rate, Tons/Day	45
Naphtha Wash, Bbls./Day	600
"Drier" Steam, M lb./Day	35
Estimated Colors:	
Charge, NPA	1½-2
Product, Saybolt	25-30
Percolator, °F	150

Economics: Investment costs depend on the size of the unit, but should be between $500-$800 per barrel of charge for waxes, and $300-$600 per barrel of charge for lubricating oils. This is for the complete battery limits equipment (erected) including a vacuum deodorizer, percolator, wash tower, drier, clay regenerator and cooler, naphtha fractionator and quench tower, and all auxiliary equipment. Typical utility consumption for wax percolation is given below:

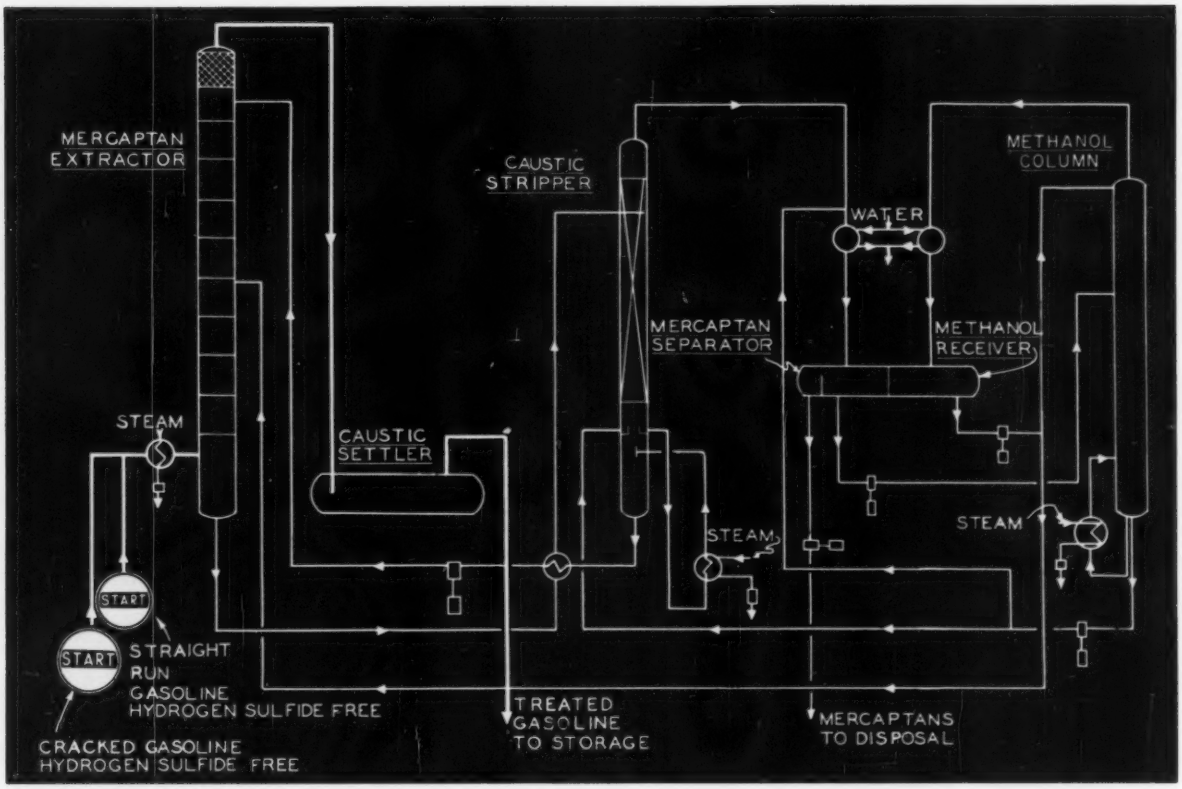
	Per Barrel Feed
Steam (400 psig*), Lb.	180
Steam (100 psig), Lb.	110
Power, KW hr.	0.5
Water (Cooling—30°F rise), gal.	570
Fuel, M Btu	192

* High-pressure steam not needed if hot oil is used for heating drier. Fuel requirement and 100 psig steam requirement would be higher.

Annual maintenance cost should be less than 5 percent of initial investment.

Commercial Installations: There are two large lubricating oil decolorizing units in Europe, and a wax decolorizing unit in the United States, at the present time. The process is also being used outside the petroleum industry.

Reference: PETROLEUM REFINER 34, No. 9, 206 (1955).



Unisol Mercaptan Extraction — UNIVERSAL OIL PRODUCTS COMPANY

Application: Extracts mercaptan sulfur compounds and certain nitrogen compounds from gasoline and higher boiling petroleum fractions.

Product: The mercaptan content of the treated product can be controlled to any level desired—from 95 percent to complete removal (Doctor sweet). If complete removal is not economically desirable, the product may be made Doctor sweet by short-time storage in the presence of an inhibitor. Octane number improvements at the 3 cc tetraethyl lead level range from one to three or more points, depending on the mercaptan sulfur content of the untreated gasoline.

In comparisons of the properties of Unisol treated gasoline with the raw gasoline or with the product obtained by conventional sweetening, it is generally found that Unisol treating improves inhibitor susceptibility and lowers ASTM gum, and that copper-dish gums, after inhibiting, are considerably lower.

Modifications not shown in the flow diagram above enable the process to remove 95 percent or more of the mercaptans from distillates such as kerosine and domestic heating oil, thereby producing oils with superior odor characteristics. Pyrrole nitrogen compounds, which are detrimental to fuel oil stability, also are removed by the process. Filter and burner tip plugging tendencies of domestic fuel blends of virgin and catalytically cracked cycle stocks are greatly reduced by Unisol treating.

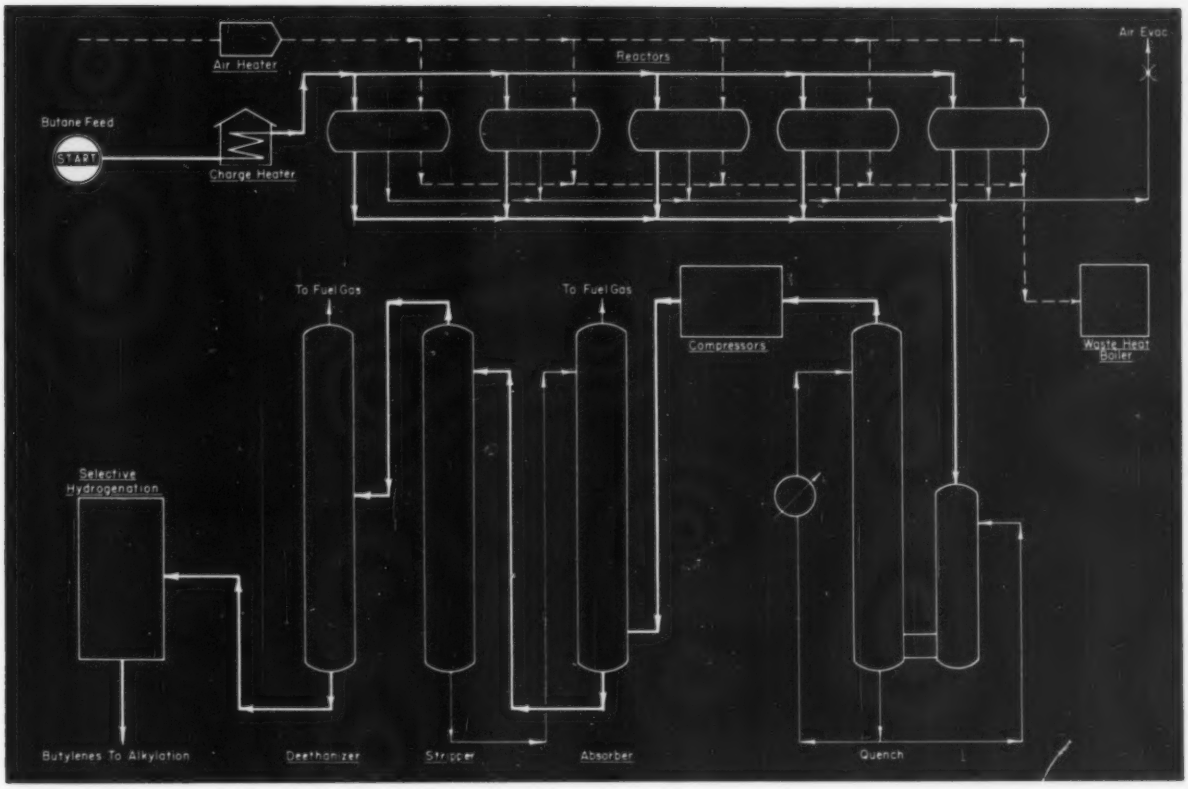
Description: Hydrogen sulfide-free gasoline is charged to the bottom of an extraction column where it meets in countercurrent flow an aqueous solution of methanol and caustic soda. The caustic solution is introduced near the top of the extractor and the methanol enters near the mid-point. The caustic soda is introduced separately, above the methanol inlet, in order to recover any methanol dissolved in the gasoline.

Treated gasoline is recovered as an overhead product, and receives no subsequent treatment except addition of inhibitor. The mercaptan-rich caustic-methanol solution is withdrawn from the bottom of the extraction column and charged near the top of the caustic stripper. Here mercaptans, water and methanol are taken overhead, leaving the caustic solution as a bottom product ready for re-use.

Removal of the alcohol greatly simplifies complete stripping of the mercaptans from the caustic solution, resulting in great operating economy.

The mercaptan-rich methanol is diluted with water, cooled and collected in a separator from which the mercaptans are decanted as an oily supernatant layer for disposal. The aqueous methanol solution then is transferred to a fractionator which recovers nearly anhydrous methanol as an overhead product for return to the process, and a water bottom product. The water is charged to the caustic stripper, where it evaporates to form stripping steam. No water is withdrawn from the system.

Reference: *The Oil and Gas Journal*, 47, No. 19, 95 (1948).



Butane Dehydrogenation — HOUDRY PROCESS CORPORATION

Application: For alkylation feed preparation.
Charge: Normal butane.
Product: Butylenes for alkylation feed or by modification, butadiene for petrochemicals production.
Description: The Houdry Dehydrogenation process is an adiabatic fixed bed catalytic process that may be operated selectively to produce mono and diolefins either separately or concurrently.

In a typical operation for butylenes only from normal butane charge, the feed is preheated to reaction temperature prior to contact with catalyst in the horizontal fixed bed reactor. Hot effluent from the reactors is cooled in a quenched tower by direct contact with circulating oil, then passes to a compression cooling system. Uncondensed gases go to an absorber and stripper for recovery of C_4 and heavier material. Stripper effluent and condensed liquids are stabilized and selectively hydrogenated to remove diolefins. The product of these operations is a high quality alkylation feed stock.

Power-operated valves are controlled by a special cycle timer which programs the reaction, purging, and regeneration sequences. Hydrocarbons are purged from the onstream reactor prior to regeneration, and combustion gases are purged after regeneration.

This process employs catalysts in the form of cylindrical pellets consisting of active alumina impregnated with 18 to 20 percent chromic oxide. Catalyst is regenerated in the reactors by burning off the coke deposit with preheated air.

Inert granular material of high heat capacity may be mixed with the active catalyst in predetermined amounts, to obtain the desired heat capacity of the catalyst bed.

Operating Conditions: In this cyclic process the operating conditions are chosen to give essentially adiabatic operation with the heat required for reaction during the onstream period substantially the same as that supplied by combustion of coke deposit during catalyst regeneration. The major process conditions normally will be within the following ranges:

Temperature—1,000° to 1,200° F
Pressure—5 inches Hg absolute or higher
Space Rate—1 to 3 vol. charge/hr./vol. catalyst
Onstream Period—7 to 15 minutes.

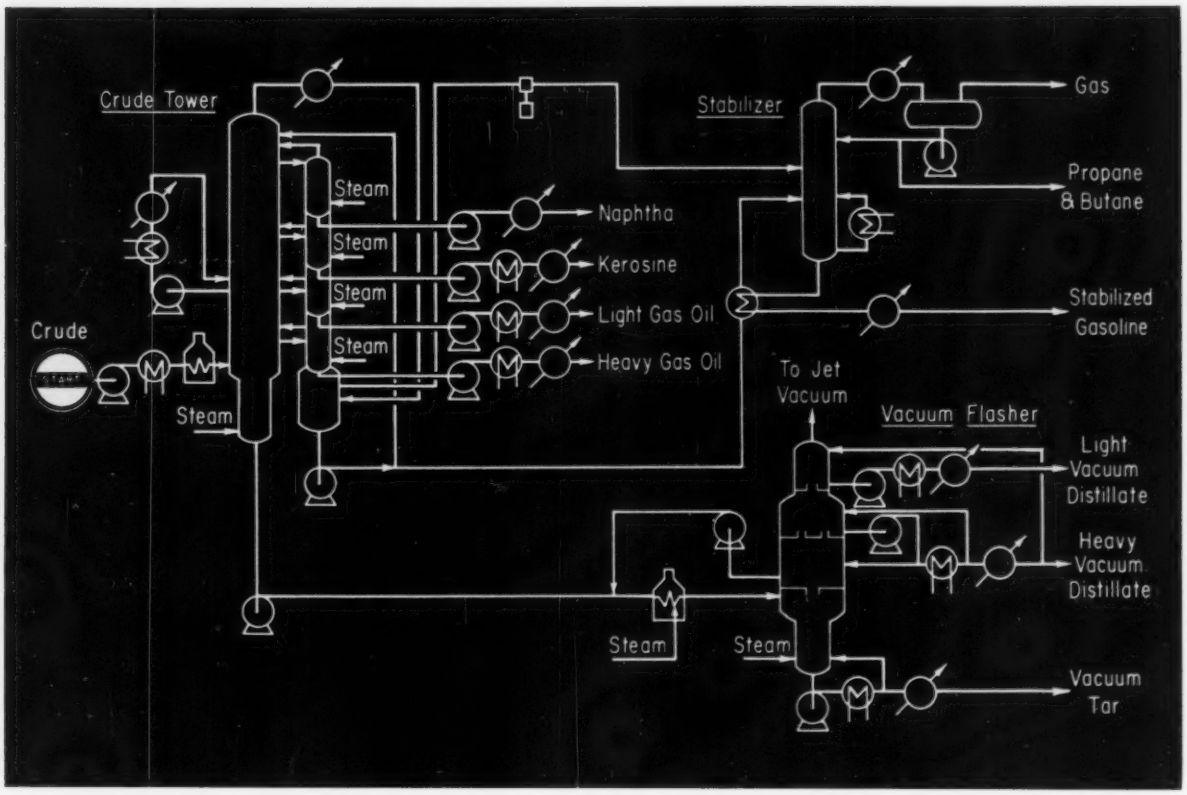
Yields: When making butylenes for alkylation feed, ultimate yields of olefin from butane are 83.7 weight percent of converted material which demonstrates the selectivity and efficiency of the operation.

References: PETROLEUM REFINER 33, No. 12, 173 (1954).

TYPICAL ONCE-THROUGH YIELDS FOR BUTYLENE PRODUCTION

	WEIGHT PERCENT ON FEED	
	Total Reactor Feed	Alkylation Feed Stock After Selective Hydrogenation
Dry Gas (including H_2)	.....	5.7
Propane	.....	1.2
Propylene	.....	2.7
iso Butane	1.0	.7
iso Butylene	.....	.6
n Butane	99.0	50.0
n Butylenes	.....	37.9
C_5+	.....	.3
Total	100.0	99.1[1]

[1] Coke deposit on dehydrogenation reactor catalyst of 0.9 weight percent of hydrocarbon feed not included as product.



Crude Distillation for Maximum Cracking Feed — STONE & WEBSTER ENGINEERING CORPORATION

Application: To obtain maximum catalytic cracker feed by distillation of crude oil.

Products: The products shown are typical of a combination atmospheric and vacuum distillation unit. Catalytic cracker feed consists of atmospheric heavy gas oil augmented by light and heavy vacuum distillates.

Description: Crude oil is preheated by exchange with product and reflux streams before passing through a fired heater to the crude tower. The exchanger arrangement is selected on the basis of distillate draw-off temperatures and fuel value to give maximum economical heat recovery.

Initial fractionation of the crude oil takes place at essentially atmospheric pressure to produce the overhead and the four side streams shown. The overhead passes to a condenser and the net light gasoline product is charged to a stabilizer for vapor pressure control. Uncondensed gas is compressed and flows to the stabilizer for recovery and fractionation. Alternatively, the stabilizer might be integrated with the catalytic cracker gas recovery unit.

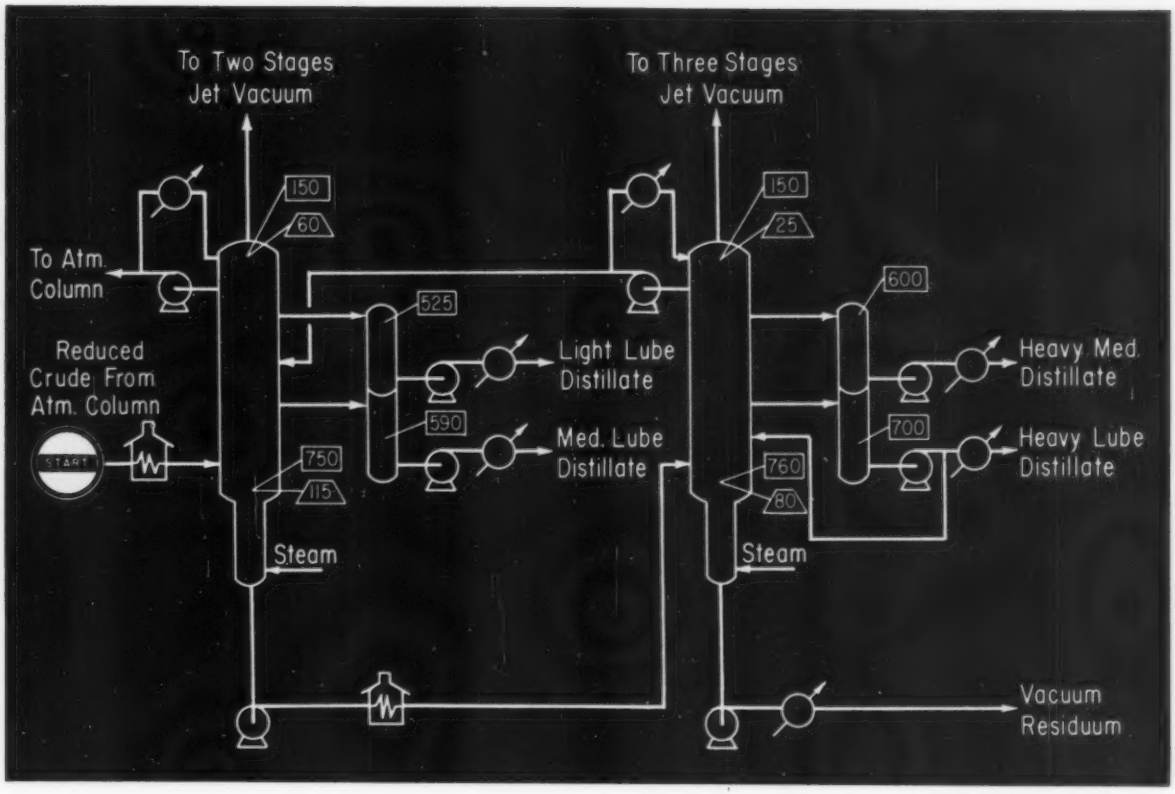
In order to obtain maximum yield of gas oil suitable for catalytic cracker feed, the bottoms from the crude tower is further heated and vaporized in the vacuum flasher. Steam is used to assist vaporization and avoid excessive temperatures which would cause undesirable cracking of the residue. The selection of the optimum operating pressure in the vacuum flasher is influenced by a number of factors, including maximum permissible flash temperature, steam to hydrocarbon ratio and temperature of cooling water for the vacuum condensers or barometrics.

Vacuum distillate is condensed within the tower and withdrawn as two side streams to improve the heat recovery. Both atmospheric and vacuum towers are equipped with circulating reflux systems for heat removal. This arrangement reduces top reflux and tower size, and provides high level heat for crude exchange and reboiler service.

The production of a catalytic cracker feed with minimum carbon residue and metal contaminants is of great importance. Carbon residue can cause excessive coke formation while metal contaminants seriously affect catalyst selectivity and product yield distribution. Provisions for minimizing entrainment in the vacuum tower are therefore imperative. In the unit shown, entrainment is minimized by the use of wash trays and wire mesh located above the vaporizer. Wire mesh may also be used in the atmospheric tower to improve heavy gas oil quality.

Liquid from the bottom wash tray is pumped back into the feed entering the heater. A continuous flow of oil over the trays below the heavy vacuum distillate drawoff is thereby assured, without diluting the vacuum residue.

Vacuum tar is stream stripped and pumped through heat exchangers to storage. This product may be cut-back with a catalytic cycle stock or other low quality distillate for use as a refinery fuel. A portion of the cooled tar is returned to the base of the tower to reduce the temperature and prevent coking of the residue.



Crude Distillation, Two Stage Vacuum — FOSTER WHEELER CORPORATION

Application: To provide higher yields of closer-cut lube fractions.

Products: Boiling point characteristics have not generally been considered important operating specifications for lube intermediate side streams; viscosity, flash and color are the main quality controls in most refineries. This explains the common occurrence of gaps between the lower boiling streams from the atmospheric column and the considerable assay distillation overlaps between lube streams from most vacuum columns. Even two stages of vacuum will produce lube distillates with overlaps, but they are markedly less than for the same viscosity distillates produced from one-stage vacuum fractionation.

The main reason for the substantial overlaps and indicated inferior fractionation between lube distillates as produced from most single-stage vacuum columns is the inability to reduce the operating pressure to that point where sufficient vaporization is effected to provide: (1) adequate reflux ratios, particularly in the lower section of the column, (2) the maximum ratio of hydrocarbon vapor/process steam in order to minimize combined vapor velocity. The common practice to compensate for this insufficient vaporization of the feed as it enters the column is to use large quantities of process steam which, in turn, increases vapor/steam velocity up the column in excess of the optimum rate conducive to good fractionation.

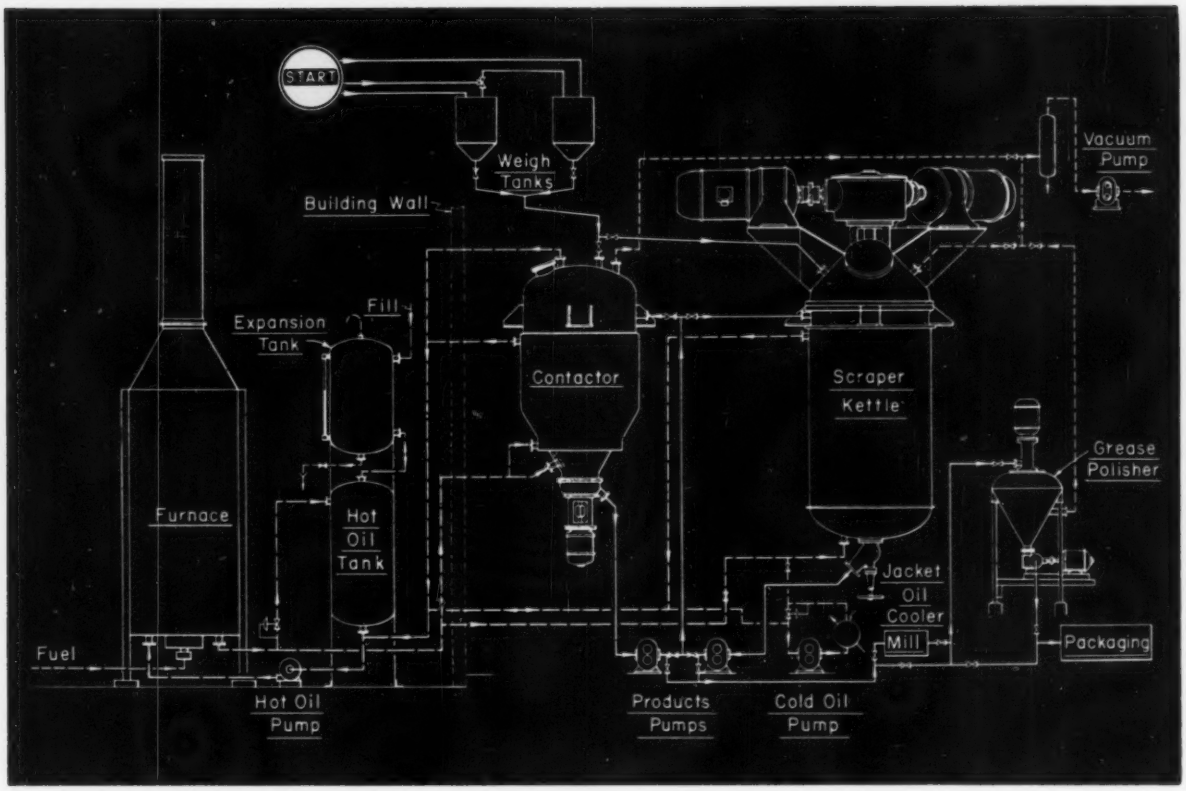
The problem, therefore, of producing closer-cut lube distillates resolves itself into one of providing the lowest practical operating pressure (absolute) or the highest vacuum in that section of the column where the lowest pressure is required, i.e., the section where the highest viscosity lube distillate is produced. Since the lowest practical pressure is mainly dependent upon the pressure drop through the column, a vacuum section for each side stream would seem to be ideal. While such a multiple vacuum system would probably provide the lowest pressure in the final stage, the refiner reasons that this extreme is not necessary and usually decides upon two stages.

Description: The reduced crude is pumped from the bottom of the atmospheric column through a direct-fired heater where its temperature is raised to 750° F and the resulting vapor/liquid mix enters the No. 1 vacuum fractionating column where three intermediates and a residue are separated. The top-of-column liquid stream splits and may be pumped either to storage or back to the atmospheric column for rerunning or reflux control in the lower plates of that column.

The residue from the first-stage vacuum column is pumped through a direct-fired heater where it is raised in temperature to 750° F; the resulting liquid/vapor mix enters the final vacuum stage where three intermediates and the final residue are produced. The top-of-column stream is pumped back to the lower section of No. 1 vacuum column for rerunning to maximize yields. A part of the heavy lube distillate stream from No. 2 vacuum column is also used as reflux control in the lower plates of that column.

Commercial Installation: Recently completed a 100,000-bpd three-stage crude distillation unit for a major Gulf Coast refiner. This unit featured two stages of vacuum.

Reference: PETROLEUM REFINER 37, No. 10, 105 (1958).



Grease Manufacturing — STRATFORD ENGINEERING CORPORATION

Application: For the manufacture of a wide range of lubricating grease.

Charge: Various compounds of fatty acids and alkali earth metals to form a soap, together with petroleum oils or other materials.

Products: Lubricating grease such as calcium, sodium lithium, barium, aluminum, mixed-base and non-soap base grease of desired specifications.

Description: The process involves accurate weight control of all feed components, intimate mixing, rapid heating and cooling, together with milling, dehydration and deaeration, whenever required. The major process equipment consists of an oil circulation heater, high dispersion contactor, scraper kettle and a grease polisher.

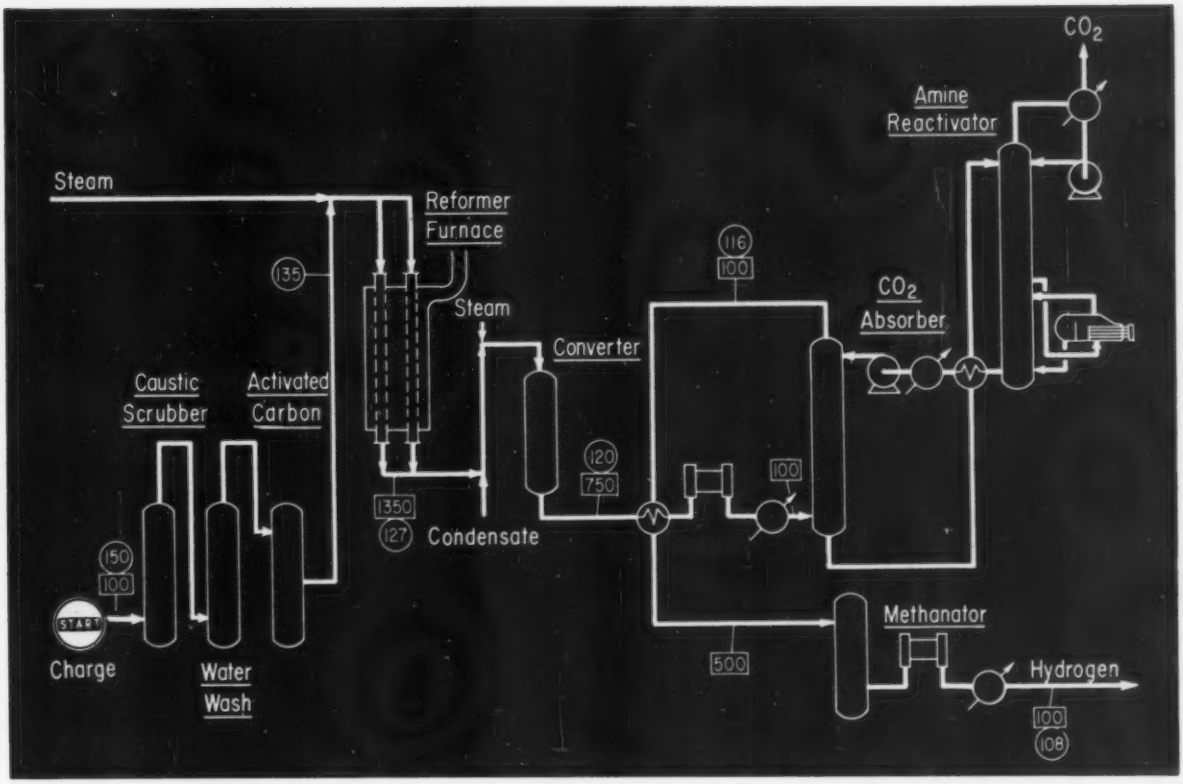
The soap is prepared by charging weighed quantities of ingredients to the contactor. The reaction is conducted at elevated uniform temperatures through the circulation of hot oil or steam through the shell and circulation tube jackets of the contactor. Time cycles as short as 30 minutes are required to complete the calcium or sodium saponification reaction and excess water may be removed simultaneously through a vacuum line, if desired. Lithium base soaps can be prepared and dehydrated in about two hours. The remainder of the oil and additives may then be charged into the contactor to complete the manufacture of the grease, or the soap may be transferred into a scraper kettle where these ingredients are added and the grease is finished to specification. The heavier types of grease are normally finished in the scraper kettle due to the high viscosity which prevails at finishing temperatures.

The hot oil circulation pump provides 400° F to 600° F hot oil to the jackets on the heating cycle. On the cooling cycle the cold oil jacket pump is employed recycling jacket oil through the cooler.

The finished grease from either the contactor or scraper kettle may be packaged directly or further processed in a grease mill and grease polisher, as required by the specifications of the final product. A typical time cycle required for the manufacture of calcium type grease is 1½ to 2 hours, and for sodium base grease, approximately 2 to 3 hours.

Pilot size equipment is available to use in conjunction with the commercial equipment for the purpose of plant guidance and the development of new and improved grease formulations.

Commercial Installation: Many installations of the described type have been in operation for a number of years, both in this country and abroad.



Hydrogen—GIRDLER CORPORATION

Application: For producing the hydrogen needed for hydrodesulfurization.

Charge: Natural gas, refinery gas, propane, butane and others.

Product: A typical analysis would show 90 percent hydrogen with less than 5 ppm carbon oxides.

Description: The flow diagram illustrates a plant using a refinery gas as process charge. The charge is purified first to remove sulfur compounds that would temporarily deactivate the catalysts used in the unit.

The desulfurized feedstock is mixed with superheated steam and charged to the hydrogen furnace. The furnace consists of a vertical combustion chamber in which are suspended alloy tubes containing a nickel base catalyst. On the catalyst, the hydrocarbons are converted to hydrogen, carbon monoxide, and carbon dioxide. The furnace supplies the heat needed to maintain the reaction temperature.

The gases from the furnace are cooled by the addition of condensate and steam and then passed through a converter containing a promoted iron-oxide catalyst. Carbon dioxide and hydrogen are produced by the reaction of the monoxide with steam.

The gas mixture from the converter is cooled and goes next to a hydrogen purifying system. The one shown here is an amine absorber. The carbon dioxide is absorbed into the amine solution and later driven off to the atmosphere by heating the rich amine solution in the reactivator.

Since some refining processes require a minimum of carbon oxides in the product gas, the oxides are reacted with hydrogen in a methanation step. This reaction takes place in the methanator over a nickel catalyst at elevated temperatures.

Hydrocarbon impurities in the product hydrogen usually are not detrimental to processes where this hydrogen will be used. Thus a considerable amount of hydrocarbon is allowed to remain in the effluent gas. These less stringent requirements permit the hydrogen furnace to be operated at higher space velocities and lower temperatures than normally would be used in high purity hydrogen plants.

Economics: The plant described here includes a waste heat boiler to supply all the steam required for hydrogen production. Operating labor requires one or two men per shift. A breakdown of the feedstock and utility requirements is given in the accompanying table.

Reference: PETROLEUM REFINER 38, No. 9, 175 (1959).

Requirements for a 10 Million Cubic Feet Per Day Plant

Materials Required	Per 1,000 scf of 90% Hydrogen
Natural gas (175 psig), scf	325
Fuel gas, M Btu net heating value	225
Electric power, kwh	0.4
Cooling water (85°F, 20°F rise), gals	700
Boiler feedwater (250 psig, 200°F), lbs	92

Light Hydrocarbon Recovery Processes

Application: Refinery gas recovery and gasoline stabilization. The original refinery application, the setting of gasoline vapor pressure in fractionating column stabilizers, continues to be a major refinery process operation though vapor recovery and fractionation units are now among the essential secondary refinery processes.

Practically all refineries in operation today include some form of gas-recovery and fractionation plant. Their design depends upon the type of refinery process units employed and the amounts of wet gas and unstable distillates to be handled. Each refinery situation requires special consideration.

Charge: Unstable distillates and wet gas streams from various refinery units such as: atmospheric crude distillation, cracking plant fractionation, catalytic reforming, hydrogen treating and coking.

Products: Gasoline, butanes-butylenes, propane-propylene, residual gas.

Description: Recovery unit designs vary according to feed stream composition and desired recovery of light ends. As noted above, the feedstock can be derived from several sources, and in such case considerable flexibility must be provided. The *absorption-fractionation* method is well-adapted to feedstock variations and is most frequently used. An alternate method is *straight-fractionation* at reduced temperature. A third method, *selective adsorption,* has been proposed but not shown to be economically feasible in gas plant service.

Propane-propylene recovery is generally 70-90 percent, although economics in some cases warrant recoveries as high as 98 percent. Ethane and lighter materials are rejected completely and together with unrecovered C_3s represent a valuable raw material for petrochemical manufacture. Methods for separating and utilizing such components as ethane, ethylene, and propylene are given in the Petrochemical Handbook (Petroleum Refiner, November 1959).

Absorption-Fractionation recovery facilities are typified by the upper flow diagram on the opposite page. The feed stream, consisting of both gas and liquid, is charged to an intercooled fractionating absorber ("absorber-de-ethanizer") operating under pressure (35-150 psia). The absorption medium is stabilized gasoline. A sharp separation between C_2 and C_3 fractions is accomplished by means of reboiled stripping vapor. (Alternately, conventional absorption may be used, followed by rich oil de-ethanization.) Overhead vapors from the absorber may be scrubbed with a heavy oil utilized in conjunction with another process unit such as the catalytic cracker fractionator.

Rich oil from the absorber passes to a stripping column (debutanizer) wherein C_3 and C_4 fractions are removed overhead. A portion of the stripped oil is recirculated to the absorber, and the remainder is withdrawn and further fractionated, if desirable, to light and heavy cracked gasoline fractions.

In the de-propanizer a separation is made between propylene-propane and butane-butylene fractions. The former fraction serves as poly-gasoline feedstock and contains no more butanes than allowed by propane LPG specifications after the propylene is converted to gasoline. The butane-butylene fraction serves as alkylation plant feedstock, and has similar limitations on propane content.

Straight fractionation recovery facilities are represented by the typical flow diagram on the lower part of the opposite page. In the case shown, the feed stream consists of gas from a treating unit, plus gas and gasoline from a cracking plant.

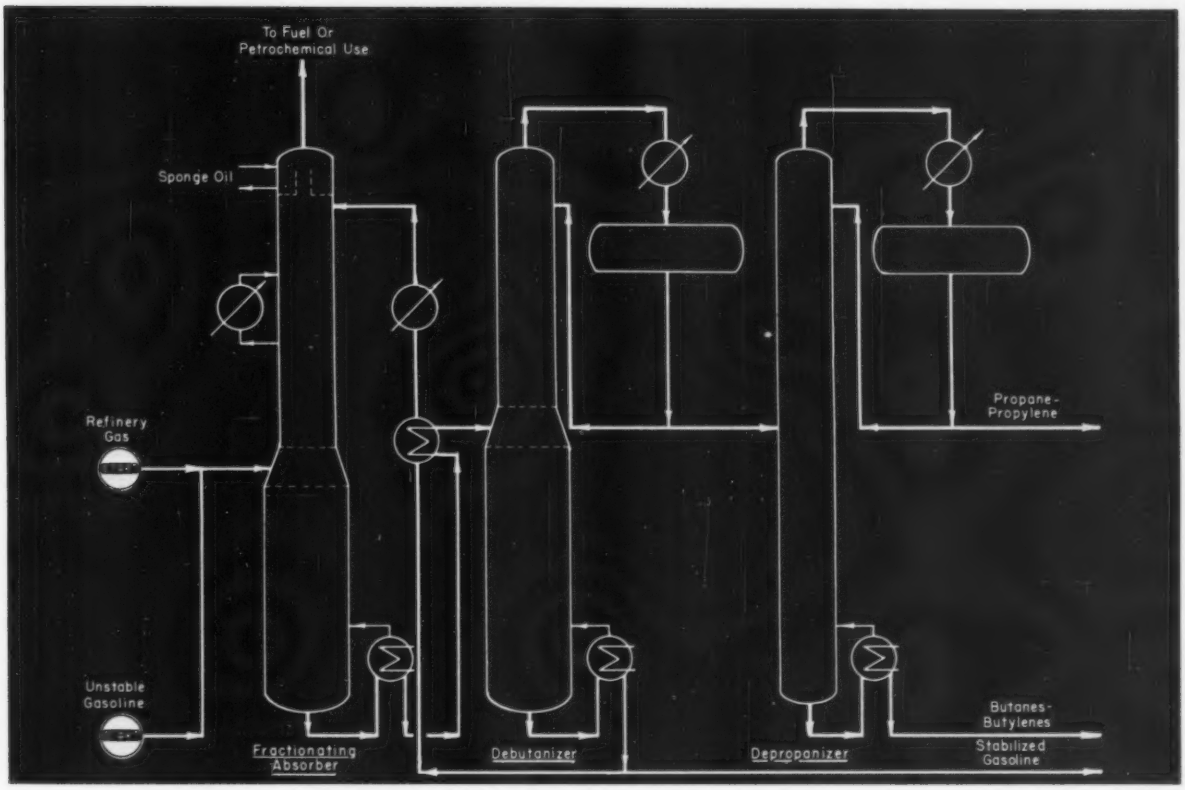
Motor gasoline from the cracking plant is charged to the debutanizer. This column is operated at 185 psig to effect recovery of the major portion of the overhead as liquid. Debutanized gasoline goes to storage.

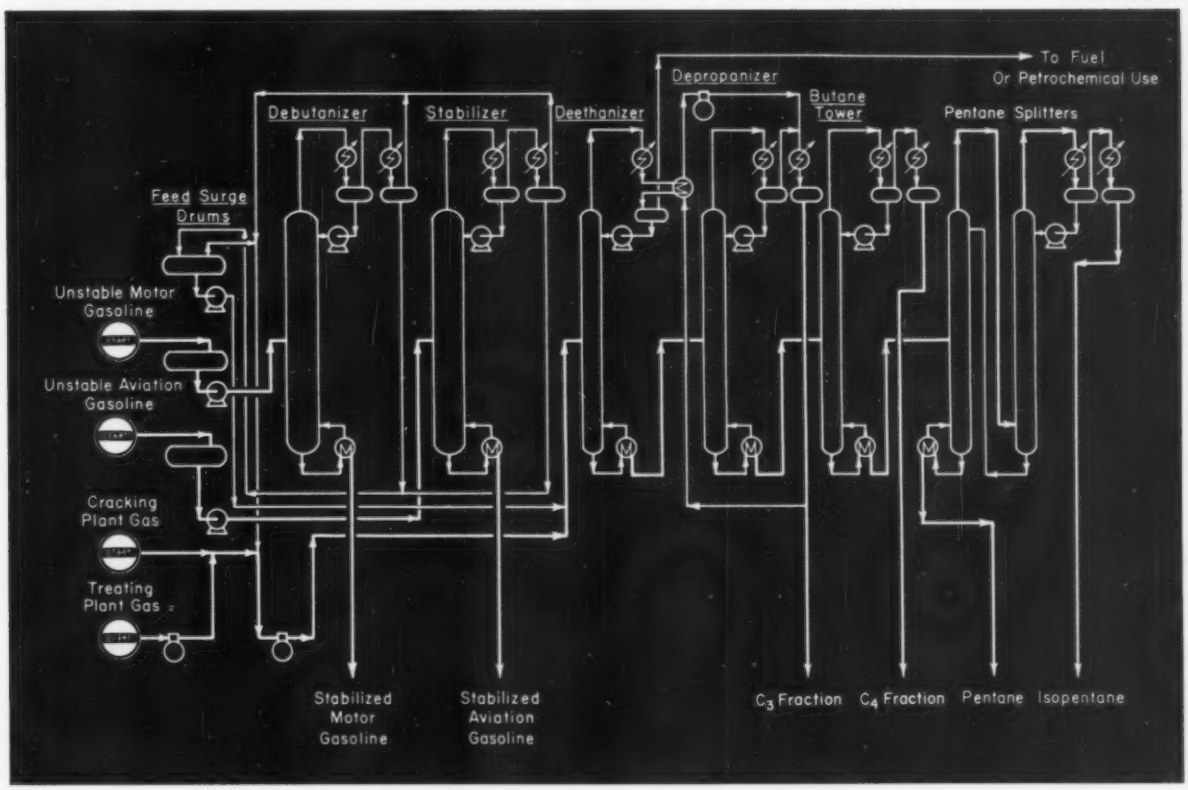
Aviation gasoline from the treating unit is stabilized at approximately the same pressure, also to obtain maximum recovery of the overhead as liquid, and the stabilized gasoline is pumped to storage. The liquid overhead products from the debutanizer and stabilizer are pumped to a surge tank from which they are sent to the de-ethanizer.

Cracking and treating plant gases are combined with the small flow of overhead gas from the debutanizer and stabilizer, compressed to 400-450 psig, and sent to the de-ethanizer. The reflux for this column is condensed in a water-cooled exchanger followed by an exchanger employing propane refrigerant. Reflux is provided at 45°-50° F, hydrate problems precluding lower temperatures. Net de-ethanizer overhead product gas goes to plant fuel or to a petrochemical unit.

De-ethanizer bottoms are depropanized at 250 psig with the overhead C_3 fraction passing to polymerization or other means of utilization. The bottoms are sufficiently depropanized so that the subsequent butane product will contain less than 1.0 mole-percent C_3s. The butane tower operates at 100 psig and separates between a C_4 overhead fraction and isopentane in the bottoms. In the flow diagram shown, the butane tower bottoms are further separated to produce an isopentane fraction of 98 percent purity. A two-tower stacked operation accomplishes this final separation.

Selective Adsorption has been proposed as a method for gas recovery in refineries. One such process is Hypersorption (Union Oil Co. of California), described in a previous Petrochemical Handbook (Petroleum Refiner, November 1957). A moving bed of charcoal separates light ends selectively, but cannot handle efficiently unsaturated hydrocarbons heavier than C_3s. No known installations have been made in refineries.


To Fuel Or
Petrochemical Use
Sponge Oil
Refinery
Gas
Unstable
Gasoline
Propane-
Propylene
Butanes-
Butylenes
Stabilized
Gasoline
Fractionating
Absorber
Debutanizer
Depropanizer


To Fuel
Or Petrochemical Use
Depropanizer
Debutanizer
Stabilizer
Deethanizer
Butane
Tower
Pentane Splitters
Feed Surge
Drums
Unstable Motor
Gasoline
Unstable Aviation
Gasoline
Cracking
Plant Gas
Treating
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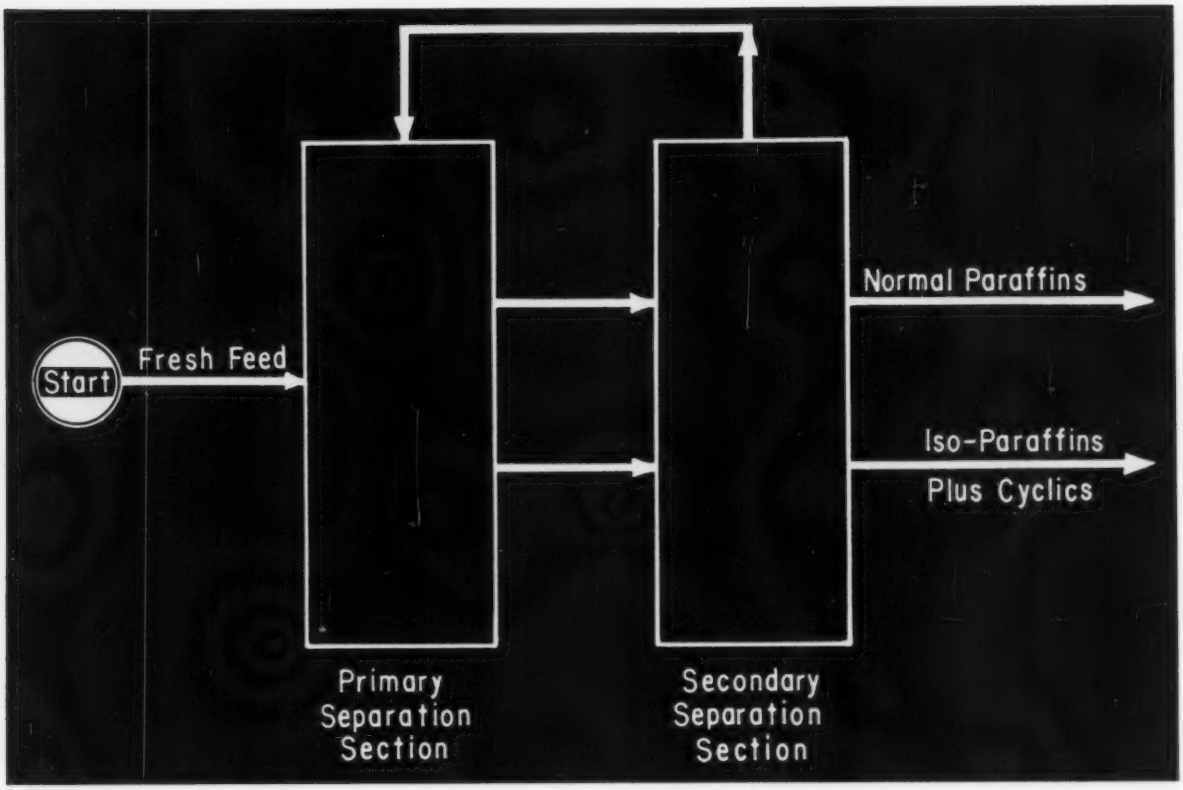
Gasoline
C3 Fraction
C4 Fraction
Pentane
Isopentane



Molex — UNIVERSAL OIL PRODUCTS COMPANY

Application: A method of separating normal paraffins as a class from isoparaffins and cyclic compounds in a single processing step.

Charging Stocks: Full boiling range gasolines, light straight-run gasolines, kerosines and jet fuels.

Products: Normal paraffins, as a group, and isoparaffins and cyclic compounds, as a group. Each of the two groups are in high purity as regards contamination by members of the other group.

Description: The diagram shows the schematic flow. Basically, the separation is carried out under conditions which are easily incorporated into normal refining operations. The adsorbent (molecular sieves) is used in a fixed bed isothermal manner, and feed and separated product streams are uniform and continuous. Temperatures and pressures are moderate and ordinary materials of construction are satisfactory.

In a separation such as isobutane from normal butane, or isopentane from normal pentane, the choice between fractionation and the Molex process depends on such factors as concentration, capacity and product purity. On more complex hydrocarbon separations, such as a pentanes-hexanes mixture, Molex has pronounced technical and economic advantages. Data are shown in the table below for pilot plant separations of various stocks by the Molex process.

Reference: PETROLEUM REFINER 38, No. 4, 130 (1959).

	Stock A—Unifined 203°—378° F St. Run Mid-Cont. Naphtha			Stock B—Nat. Gaso. $C_5 + C_6$			Stock C—Light Reformate		
	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product
Analysis, Wt. %									
nC_5	....	....	....	17.5	0.4	41.2	23.0	1.7	70.3
nC_6	....	....	....	25.3	0.6	57.6	8.5	0.3	25.9
Iso-paraffins	29.2	33.8	0.4	51.5	88.2	1.1	54.0	78.1	1.7
Naphthenes	46.5	53.9	0.7	5.7	10.8	0.1	6.5	9.3	0.2
Aromatics	8.1	9.3	0.5	0.0	0.0	0.0	4.9	7.0	0.1
Olefins	tr.	tr.	0.0	0.0	0.0	0.0	3.1	3.6	1.8
Total n-paraffins. Wt. %	16.2	3.0	98.4	42.8	1.0	98.8	31.5	2.0	96.2
Research O. N., Clear	44.7	....	....	66.8	84.1	46.0	78.6	90.0	56.7
Research O. N., + 3 ml. TEL	70.2	....	....	87.4	98.4	72.9	94.5	102.0	80.8
Motor O. N., Clear	....	....	....	....	83.6	41.9	76.0	85.9	53.3
Motor O. N., + 3 ml. TEL	....	....	....	....	101.2	75.1	95.1	101.2	....
Luminometer No.	75	....	189	....	....	....	....	....	....
Freezing Point, °F	....	....	—60°	....	....	....	....	....	....

Check List for Better Estimates

By using this check list, sufficient data will be given to the estimator, resulting in a better and more accurate estimate

John Mylo
The Chemstrand Corporation, Decatur, Ala.

COMMUNICATION in transmitting estimating information is usually poor at best. From the general data most often provided, little or no information can be extracted. This particularly is true when the information is supplied for preparing evaluation or order of magnitude estimates. Since equipment cost is the basis for these estimates, proper descriptive data on equipment must be furnished. This review includes a check list for engineers who furnish estimating information.

Studies for evaluation or order of magnitude type estimates usually consider only equipment within battery limits. The practice is to include all equipment which is required for the process under consideration. A clear understanding of what is within battery limits should be agreed upon as part of the basis of the study.

The estimator needs a complete description of each piece of equipment. He also needs to know how this equipment fits into the overall project. A good flow sheet serves that purpose. Any large or unusual piping, valving or special material of construction required should be noted with the related piece of equipment.

Data for handling utilities, waste disposal, and spare equipment are essential to the estimator. The general scope of instrumentation should be outlined. If the degree of instrumentation can be compared to an existing company installation or a previous study, this should be mentioned. Any unusual instrumentation should be described. The general location, if known, should be given since climatic conditions may alter the types of buildings, general protection, etc.

A scope of work should be attached to each estimate describing concisely the premise of the project. This scope of work will serve to assure the completeness of the study or estimate and fully explain the intent of the project.

Revisions. The estimator works *for* a total and not *to* a total. Remember this when estimates are evaluated with the intent of cutting the estimated total without changing the scope. Estimates should not be changed without the agreement of the estimator; any estimates so changed without his agreement relieves the estimator of his responsibility.

Much has been written as to what is required in selecting process equipment from the design standpoint. But when estimates for this equipment are requested, the information provided is often too limited. As an example, consider a centrifugal pump. The process engineer calculates the volume, total dynamic head, horsepower, selects the material of construction, selects special seals, etc., which make up this unit. For estimating purposes the information furnished is too often: One (1) centrifugal pump 30 gpm. One can readily see that

See check list on next page . . .

About the Author

John Mylo

John Mylo was chief estimator for The Chemstrand Corp. at Pensacola, Fla., when this article was prepared. He was responsible for the preparation of all types of cost estimates. He is presently an estimator and cost engineer in Plant Engineering at Decatur, Ala. Mylo has 14 years experience in construction as estimator, cost engineer, superintendent, and project engineer with several engineer-constructor companies. He attended Purdue University and is a charter member of the American Association of Cost Engineers.

Check List for Better Estimates . . .

without detailed information the estimator is at a loss to derive an accurate cost.

The check list given here has been compiled to assist engineering personnel in supplying adequate information to the estimator for estimating capital investments. It is intended to avoid omission of necessary information but in no way is a substitute for common sense and engineering skill. The check list and equipment description requirements shown in Table 1 should serve as a guide. The following items, along with a complete definition of scope of the project, must be included as part of the package transmitted to the estimating department:

1. Process flow sheets
2. Complete equipment description (See Table 1)
3. Utilities equipment, if this is to be included
4. Waste disposal equipment, if this is to be included
5. Spare equipment requirements
6. Instrumentation requirements
7. Storage (raw material, intermediate, and product) requirements
8. General location if known
9. Buildings
10. General facilities
11. Services

TABLE 1—Check List for Equipment Description Requirements

	Mixer Settler	Mixer	Compressor	Separator	Storage Tank	Fractionating Column	Heat Exchanger	Pump	Hold Up Tank	Gas Filter	Waste Heat Boiler	Absorption & Extraction Column
Number Required	√	√	√	√	√	√	√	√	√	√	√	√
Size*	√	√	√	√	√	√	√	√	√	√	√	√
Design Pressure	√	√				√	√		√	√	√	√
Suction Pressure			√					√				
Discharge Pressure			√					√				
Type**		√	√	√	√		√	√	√	√	√	
Drive-Size & Type	√	√	√					√				
Mat'l of Constr.	√	√	√	√	√	√	√	√	√	√	√	√
Vapor Flow-Lbs/Hr												
Vacuum & Steam Pressure												
Special Features	Agitation, size and power of agitators, specials	Internal construction specials	Specials	Specials	Floating roof, head type, specials	Specials	Number of passes, specials	Drive, seals, specials	Dished or flatheads, cooling or heating, jackets, unusual draw offs, specials	Details of filters specials	Quantity of steam generated, size of auxiliary steam drum	Specials

	Conveyor	Solid Elevator	Storage Bin	Grinder	Drier	Reactor	Vacuum Jet	Filter	Motor	Evaporator	Feeder
Number Required	√	√	√	√	√	√	√	√	√	√	√
Size*	√	√	√	√	√	√	√	√	√	√	√
Design Pressure						√				√	
Suction Pressure											
Discharge Pressure											
Type**	√	√	√		√		√	√	√		√
Drive-Size & Type	√	√		√	√	√		√	√		√
Mat'l of Constr.	√	√	√	√	√	√	√	√	√	√	√
Vapor Flow-Lbs/Hr		√					√				
Vacuum & Steam Press.							√				
Special Features	Driver type and size, specials	Type and power of drive, degree of tightness, specials	Degree of tightness	Power requirements, specials	Type of heating with necessary description, description of feed and discharge systems, specials	Agitation (Size and power of agitators) cooling jackets, (area, D.P., and material of construction) amount and price of catalyst supports, specials	Inter-coolers and after-coolers (with information as for heat exchangers) baro-metric leg, specials	Specials	Specials	Specials	Power requirements, special

NOTE:
* Be specific as to capacity, GPM & head, area, No., of Stages, Horse Power, Vapor Outlet, No., Diameter & Length of Tube, CFM, Dimensions-Volume, Diameter & Height, etc.
** Type of construction, No., Trays & Spacing, Height & Type of Packing, Centrifugal, Reciprocating, Metering, Gas or Diesel Engines, Electric or Steam Drives etc.
NOTE: Where possible supply the Manufacturer's name.

Trouble Shooting . . .

Electrical Distribution Problems

From lightning to termites, Mobil's Beaumont refinery has had its share of troubles. Here are the problems—and the remedies tried to cure them

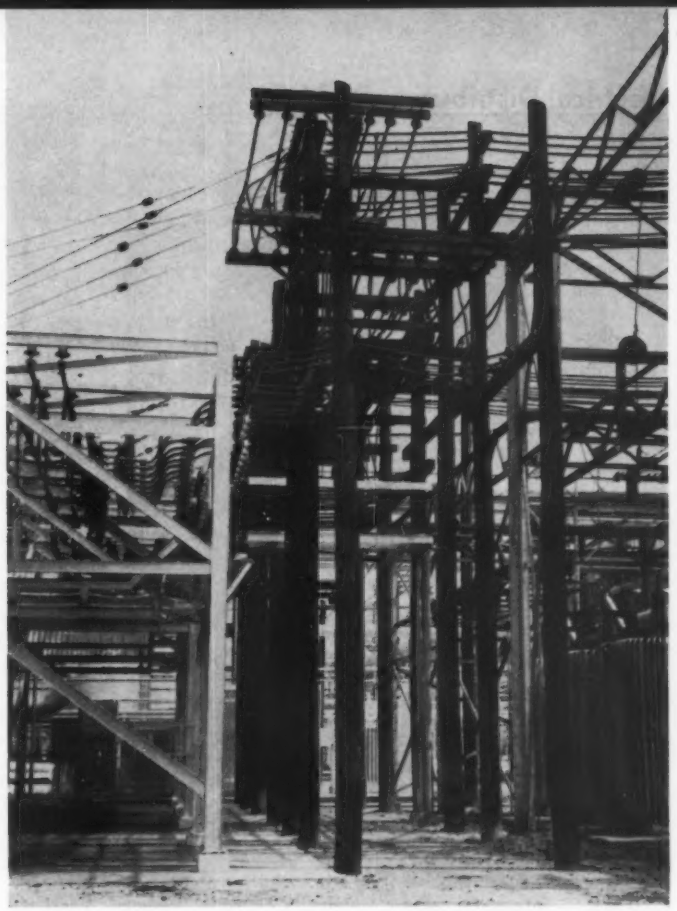


FIGURE 1—Crowded get-away structure makes replacement tough job.

John C. Petkovsek
Mobil Oil Co., Beaumont, Texas

ONE FOGGY MORNING LAST YEAR the strip heaters in a 13.8-KV substation bus shorted out causing it to blow up. Corona had tracked across the bus supports. Protective relays cleared the fault but the power plant operator promptly reclosed one of the breakers into the fault! It goes without saying that we replaced a section of the bus.

Investigation disclosed that there had been lax preventive maintenance. Even though strip heaters had been installed in the bus, an improper installation caused them to short out. Strip heaters were found to be necessary. Also it was found that general design, including bus support materials, is very important.

Lightning Protection. In the past years the plant has suffered numerous outages and equipment failures from lightning. It was learned the hard way that the proper installation of static lines and lightning arrestors is essential in this area. Repeat: *proper installations.*

Before 1942 the Beaumont refinery was served by one power plant operating at 2400 volts. Power Plant No. 2 was built in 1942 and an existing 2400-volt circuit was converted to 13.8-KV to serve as a tie line. The record of this line before its conversion to 13.8-KV is not available. However, after its conversion to 13.8-KV, it averaged about five or six outages per year from lightning.

About five years ago management authorized rebuilding the line properly. This included replacing the eight-foot cross arms with ten-foot arms and raising the static wire to form a 60-degree cone of protection. Since this work has been completed there has not been a single outage on this line that could be traced to lightning.

FIGURE 2—Termites ate their way up a 35-foot pole, out the arm and through this insulator pin.

Also, backing up the experience with the proper use of static wires is the experience record at the Magpetco Terminal near Port Neches, Texas. This terminal is basically a tank farm with shipping facilities. Until three years ago very few of the lines in this terminal had static wires. Accurate records have not been kept of the number of outages at the location. But the personnel there estimated that prior to the installation of static wires

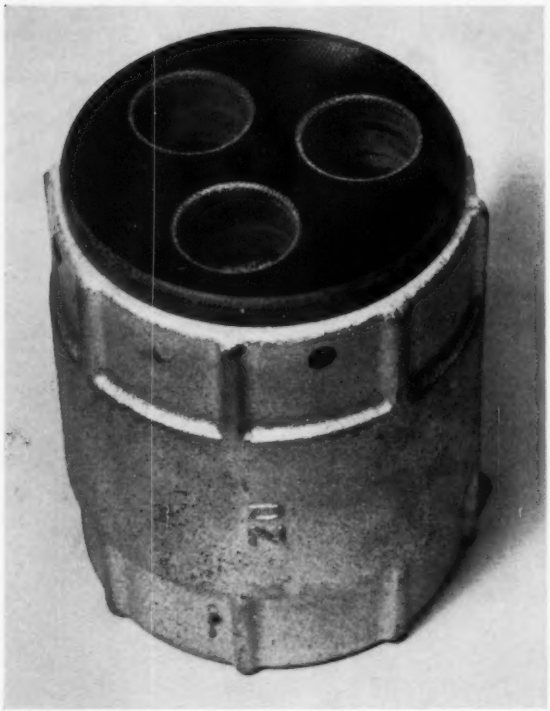


FIGURE 3—Because insulated conductor extends through this terminator, it doesn't matter if water gets inside.

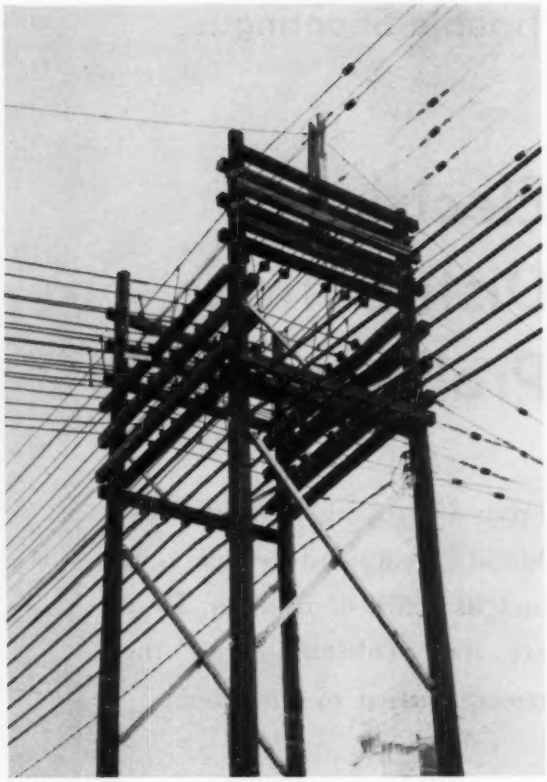


FIGURE 4—There are eight, 2400-volt circuits on this structure—four open wire and four aerial circuits.

there were approximately 15 outages per year caused by lightning. After the installation of static wires there have been no outages due to lightning on the secondary side of the Utilities Substation.

As to the proper installation of lightning arrestors, originally the plants were built with lightning arrestors just being thrown in haphazardly along the lines. These did not do very much good. In revamping the system about three years ago it was made sure that arrestors were installed at the proper points, i.e., at load take-offs and at impedance change points. Also it was made certain that surge capacitors were installed on services to rotating machines.

As a result of all this motors damaged by lightning have been reduced to less than ten per year. Actually, the total for 1959 was four. This is with approximately 3,000 motors in service and this is considerably better than several other plants in this vicinity. This plant is sold on proper lightning protection.

Termite Troubles. Several years ago—about 1953—it was found that termites had eaten the heart out of the poles in a get-away structure at Power Plant No. 2. They ate creosote and all. Maybe there is growing a super race of termites! You can see from the picture (Figure 1) how crowded this structure is and what a job it became to replace it. Incidentally, at that time these poles were only about five years old. They were replaced and a local termite exterminator treated the ground around the poles. So far, no more termites have been found at this location. However, they have been found in many other locations and as a result, termite treatment has been used around the base of most of the main line poles. A few were missed and this is evidenced by Figure 2 (look closely and you will see termites in the wood). This insulator was removed from the top arm of a 35-foot pole in January of this year. Had you ever thought about those hungry termites eating their way up through a pole and then eating the insulator pins? They did at Beaumont!

Underground Cables. The distribution system is basically overhead, with underground installations being restricted to service entrances, motor leads, etc. In past years these underground installations have been made with lead covered cables using pot heads for terminations. Failures of lead covered cables were not uncommon, because of moisture either in the cable or the pot head. Generally this would be caused by electrolytic attack on the lead sheath or the expansion and contraction of the compound used in the pot heads. Because of these troubles, and for other reasons, synthetic insulated cables have been adopted as standard for underground work. Also, shielded cables are not used except on our 13.8-KV system.

This has lead to the elmination of pot heads for terminations and also the elimination of their troubles. The type of cable terminator generally used now is shown in Figure 3. You will note that the insulated conductor extends through this terminator and it does not make

much difference if the water does get inside the terminator. So far, after about five years of using this type of terminator, no failures have been reported.

Aerial Cable Maintenance. So far not much trouble has been experienced on the aerial cable system. In fact, there has been very little since it was installed about three years ago. However, the experience during the installation period proves why high voltage DC testing is necessary.

A new 13.8-KV tie line was being installed between the two power plants. This line was 300-MCM butyl insulated cable about 4500 feet long. It was planned to test this line at about 40-45-KV DC. However, at about 18-KV the tester would trip off. The trouble was isolated into one phase and to find its exact location was the new problem. This was solved by stationing linemen along the cable route and then charging the two good conductors as capacitors and then discharging them through the faulty conductor. The discharge sounded like a gun going off at the point of the fault. Visual inspection revealed a nail hole in the insulation. Once located it was not hard to repair.

Shortly after part of the cable system was installed there was another experience. An explosion in one of the process units near a 13.8-KV cable sent a relief valve down on top of the cable. It bounced off but only after it had cut through the jacket and the shielding tape. It did not cut into the insulation. Visual inspection raised the question as to how long it would be before internal corona cutting might cause a fault. One week later when the damaged portion was removed it was found that internal corona cutting had already started. The repairs were simple. All that was necessary was to cut out the damaged insulation, shield and jacket and then rebuild these portions with tapes in the same manner as we would a splice. This sounds easy but two men spent six hours on the job.

In lower voltages and in smaller sizes, aerial cable will probably prove more economical. However, with larger conductors at higher voltages the cost of aerial cable becomes something for which you must prove a pay-out. This can sometimes be done with space reductions, safety, regulation or lower maintenance costs. Properly selected and installed, it will definitely lower maintenance costs.

Space Problems. It does not matter where power lines are built, someone always thinks they are in the way. Right-of-way is a constant problem, but seldom is it necessary to remove a line as in one case where someone failed to note that the location selected for a new oil storage tank was directly under a power line. And the tank was to be built to a greater height than the power line! With so many circuits in such a small space as this refinery, congestion on the poles sometimes becomes a major problem.

In Figure 4 there are a total of eight 2400-volt circuits on this structure. The first four were built with open wire while the last four were built with aerial cable. Can you picture the congestion resulting from eight open wire circuits? Or how would you like being a lineman that had to climb around in this congestion?

In this case the aerial cable was justified because it reduced both height and the congestion in which linemen must work.

Connectors. Of course there also have been a few connector troubles. Generally, most of these troubles do not show up until after the connectors have been in service for several years. After that it is hard to prove which caused the trouble, a poor connector or poor workmanship. Quite often both were found to be at fault. However, the linemen checked some of the connectors and found several that were "off-spec!"

Insulator Leakage In Contaminated Areas. On overhead lines in the vicinity of cooling towers, and in one case adjacent to a boiler blowdown stack, leakage of insulators has caused pin failures and damage to cross arms. Special design insulators and higher voltage rated insulators have been tried with moderate success, but we feel that this has not been an adequate answer. The problem has been approached on recent installations by the use of aerial cables, taking care to install lightning arrestors at the point of change from open wire to cable. This likely is the answer to the problem, although it is sometimes the more expensive answer.

Voltage Regulation. Although distribution lines are not especially long, the high load density has created some voltage regulation problems. There are no voltage regulators installed on the distribution lines. However, several 600-KVAR capacitor banks have been installed at locations where a steady load needs this power factor correction. A few years ago in calculating a new circuit using 300-MCM open wire, a voltage drop of almost 20 percent was calculated when certain large motors were being started. A similar calculation using 300-MCM aerial cable reduced this drop to only slightly more than 10 percent. In general, voltage regulation problems are being solved by load growth that has caused a shortening of existing 2.4-KV feeders back toward the power plants and by the addition of substations to serve the outlying areas.

This paper was originally presented to the American Institute of Electrical Engineers, Southwest District 7 meeting in Houston, April 4-6, 1960.

About the Author

Petkovsek

John C. Petkovsek is the engineering supervisor of utilities at Mobil Oil Company's refinery in Beaumont, Texas. He directs the activities of engineering personnel in the Utilities Group of the Engineering Design Department in providing planning engineering and consulting services for utilities.

Mr. Petkovsek received a bachelor of electrical engineering degree from Georgia Tech in 1946 after which he joined Magnolia Petroleum Company's Refining Division in Beaumont as a junior engineer. Before assuming his present position, he held the title of engineering supervisor of communications and electrical. He is a member of AIEE, a senior member of IRE and a registered professional engineer in Texas.

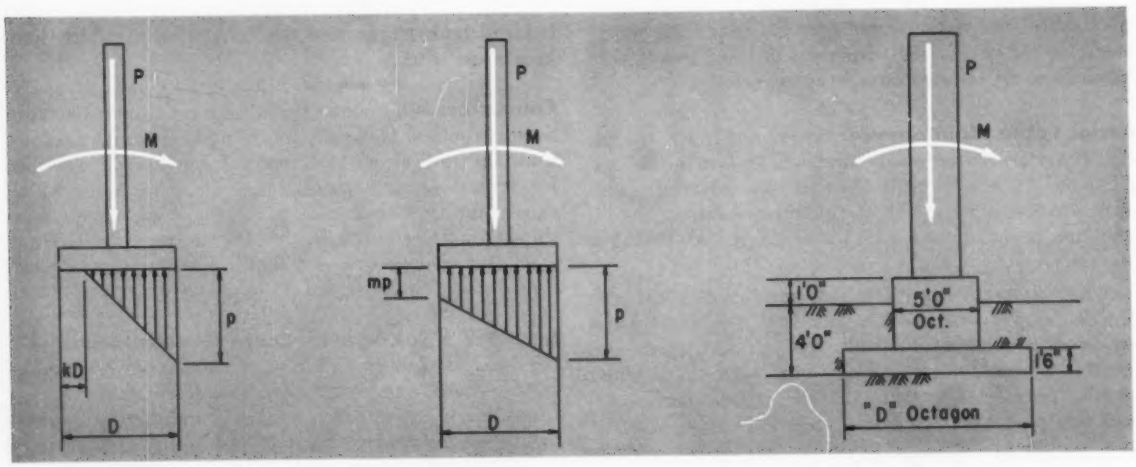


FIGURE 1 FIGURE 2 FIGURE 3

Foundation Sizing Simplified

Tables can be used to select foundations as easily as capacity tables are used to select pumps

David H. Kannapell, Girdler Construction Corp., Louisville, Ky.

JUST AS a designer can select a storage tank using capacity tables, so a structural designer can choose a foundation based on tables of capacities. Entering the tables with a given weight and moment (or eccentricity) you can quickly select the minimum size of foundation required. In addition, you can readily determine the distribution and magnitude of soil pressures under the foundation.

How to Make Capacity Tables. Two cases of foundation loading are considered in developing capacity tables. The first case consists of a loading which produces uplift on part of the foundation. This case is shown in Figure 1. The second case covers bearing under the entire foundation and is shown in Figure 2.

For calculating the capacities of an octagon foundation subjected to soil pressures as shown in Figure 1, the following formulas[1] are used.

$$C_1 = \frac{\pi/8(1-2k) + \left(\frac{1}{2} - \frac{2}{3}k + \frac{2}{3}k^2\right)\sqrt{k-k^2} + \frac{(2k-1)}{4}\arcsin(2k-1)}{2(1-k)}$$

$$C_2 = \frac{\pi/64\,(5-8k) + \left(\frac{5}{16} - \frac{7}{24}k - \frac{1}{6}k^2 + \frac{1}{3}k^3\right)\sqrt{k-k^2} + \frac{(8k-5)}{32}\arcsin(2k-1)}{2(1-k)}$$

$$E = D_e \times \frac{(2C_2 - C_1)}{2C_1}$$

$$P = C_1 p D_e^2$$

$$M = EP$$

The capacities of an octagon foundation subjected to loading as shown in Figure 2 are determined from the following formulas[1].

$$E = \frac{D_e}{8} \times \frac{(1-m)}{(1+m)}$$

$$P = 8E^2 p \times \frac{(1+m)^3}{(1-m)^3}$$

$$M = EP$$

NOTATION

P = Concentric vertical load capacity, kips

M = Overturning moment capacity, foot-kips

E = Eccentricity of load to produce corresponding moment, feet. E = M/P.

p = Unit soil pressure, kips per sq. ft.

k = Ratio of unloaded length of diameter to diameter of inscribed circle of octagon. Used in Figure 1 loading only.

m = Ratio of minimum unit soil bearing to maximum soil bearing. Used in Figure 2 loading only.

D_e = Diameter of a circle equivalent to the inscribed diameter, D, of an octagon, feet. $D_e = 1.04D$.

C_1 and C_2 are coefficients used to shorten algebriac operations.

By decrementing k and incrementing m, capacities of a one-foot diameter octagon are developed based on a maximum unit soil pressure of one kip per square foot. The relations of the capacities and eccentricities of any other diameter octagon, D_x, to those for the one-foot octagon are as follows:

$$E_x = E_{1'-0''} \times D_x \text{ for a given "k" or "m" value}$$

$$P_x = P_{1'-0''} \times D_x^2 \text{ for a given "k" or "m" value}$$

$$M_x = M_{1'-0''} \times D_x^3 \text{ for a given "k" or "m" value}$$

Tables 1 and 2 are illustrative of tables that may be used to estimate and design footings subjected to the forces described. The tables were developed on an electronic digital computer.

ILLUSTRATIVE PROBLEMS

To demonstrate the use of the capacity tables, several illustrative problems are presented as follows:

Problem 1. Size an octagonal foundation for the self-supporting vertical vessel shown in Figure 3, using the following data:

$p = 2000$ lbs./sq. ft. (2.0 kips/sq.ft. at 4'-0" below grade)

$P_v = 50$ kips, weight of tower

$M = 147$ ft.-kips, about base of tower.

Since the tables show capacity of foundations based on a maximum soil pressure of 1 kip per square foot, it is necessary to first use an "adjusted" value for P and M to compensate for the larger soil bearing value. The following relationships are used:

$$\text{"Adjusted" } P = \frac{P}{\text{Allow. pressure, kips/sq.ft.}}$$

$$\text{"Adjusted" } M = \frac{M}{\text{Allow. pressure, kips/sq.ft.}}$$

The eccentricity, E, remains the same for any soil pressure.

Step 1—Assume weight of foundation, pier and earth backfill as 50 kips.

$$P = 50.0 + 50.0 = 100 \text{ kips.}$$

Step 2—Calculate eccentricity and "adjusted" value of P:

$$E = \frac{147}{100} = 1.47 \text{ ft.}$$

$$\text{"Adjusted" } P = \frac{100.0}{2.0} = 50.0 \text{ kips}$$

Step 3—Enter tables with "e" and "adjusted" P. Select 11'-0" octagon (Table 1) (table capacity P = 51.393 kips, "E" = 1.429 ft., k = 0.0).

Step 4—Check assumed foundation weight:

Pier:	5'-0" Oct. 3'-6" high	= 10.87 kips
Foundation:	11'-0" Oct. 1'-6" thick	= 22.50 kips
Backfill:	(100.2-20.7) x 2.5 x 0.1	= 19.88 kips
	Total	= 53.25 kips

$$P = 50.0 + 53.25 = 103.25 \text{ kips}$$

$$E = \frac{147.0}{103.25} = 1.42$$

$$\text{Adjusted } P = \frac{103.25}{2} = 51.6 \text{ kips}$$

Re-enter Table 1 and check selection. Inspection indicates 11'-0" octagon is satisfactory. Since k = 0.0, the distribution of soil pressure is such that 100 percent of the foundation is under compression; minimum soil pressure is zero on the windward edge and 2,000 pounds per square foot on the leeward edge.

Alternate Solution.

Step 1—Same as in original solution.

TABLE 1—Octagon Diameter = 11.00

k or m	P	M	E
k .25	37.009	85.596	2.312
k .20	40.037	84.784	2.117
k .15	43.016	83.016	1.929
k .10	45.923	80.412	1.751
k .05	48.729	77.147	1.583
.00	51.393	73.493	1.429
m .05	53.963	69.818	1.293
m .10	56.533	66.143	1.169
m .15	59.102	62.469	1.056
m .20	61.672	58.794	.953
m .25	64.242	55.119	.857
m .30	66.812	51.445	.769
m .35	69.381	47.770	.688
m .40	71.951	44.095	.612
m .45	74.521	40.421	.542
m .50	77.090	36.746	.476
m .55	79.660	33.071	.415
m .60	82.230	29.397	.357
m .65	84.799	25.722	.303
m .70	87.369	22.047	.252
m .75	89.939	18.373	.204
m .80	92.509	14.698	.158
m .85	95.078	11.023	.115
m .90	97.648	7.349	.075
m .95	100.218	3.674	.036

Capacities based on 1000 lb/sq. ft. allowable soil bearing

Area of base = 100.2 sq. ft.

Thickness	Weight (kips)
1'—0"	15.0
1'—6"	22.5
2'—0"	30.1
2'—6"	37.6

TABLE 2—Octagon Diameter = 14.00

k or m	P	M	E
k .25	59.949	176.466	2.943
k .20	64.854	174.793	2.695
k .15	69.679	171.147	2.456
k .10	74.387	165.778	2.228
k .05	78.933	159.048	2.014
.00	83.249	151.514	1.819
m .05	87.412	143.938	1.646
m .10	91.574	136.362	1.489
m .15	95.737	128.786	1.345
m .20	99.899	121.211	1.213
m .25	104.062	113.635	1.091
m .30	108.224	106.059	.979
m .35	112.386	98.484	.876
m .40	116.549	90.908	.779
m .45	120.712	83.332	.690
m .50	124.874	75.756	.606
m .55	129.036	68.181	.528
m .60	133.199	60.605	.454
m .65	137.361	53.029	.386
m .70	141.524	45.453	.321
m .75	145.686	37.878	.259
m .80	149.849	30.302	.202
m .85	154.011	22.726	.147
m .90	158.174	15.150	.095
m .95	162.336	7.575	.046

Capacities Based on 1000 lb./sq. ft. Allowable Soil Bearing

Area of Base — 162.3 sq. ft.

Thickness	Weight (kips)
1'—0"	24.3
1'—6"	36.5
2'—0"	48.7
2'—6"	60.9

Foundation Sizing Simplified . . .

Step 2—Obtain "adjusted" values of P and M:

$$\text{"Adjusted" } P = \frac{100.0}{2.0} = 50.0 \text{ kips}$$

$$\text{"Adjusted" } M = \frac{147.0}{2.0} = 73.5 \text{ ft.-kips}$$

Step 3—Enter Table 1 with these adjusted values. Select 11′-0″ octagon as before.

Step 4—Same as in original solution.

Problem 2. This problem illustrates the method for obtaining sizes of foundations other than those given in the tables. For this problem refer to Figure 3 and use the following data:

$p = 5{,}000$ lb./sq. ft. (5.0 kips/sq.ft.) at 4′-0″
$P_v = 235$ kips, weight of tower
$M = 990$ ft.-kips

In the solution of this problem, the following relationship is used:

$$\frac{D_1^2}{D^2} = \frac{P_1}{P} \text{ or } D_1 = \sqrt{\frac{P_1}{P} \times D^2}$$

for a given "k" or "m" value.

Where D_1 = octagon diameter desired
D = table octagon diameter
P_1 = load to be carried by octagon D_1
P = table octagon load capacity.

Step 1—Assume weight of foundation, pier, and earth backfill as 85 kips.

$$P = 235.0 + 85.0 = 320 \text{ kips.}$$

Step 2—Calculate eccentricity and "adjusted" value of P:

$$E = \frac{990.0}{320.0} = 3.09 \text{ ft.}$$

$$\text{"Adjusted" } P = \frac{320.0}{5.0} = 64.0 \text{ kips}$$

Step 3—Enter Table 2. Closest capacities are P = 59.949 kips, E = 2.943 ft., k = 0.25 for 14′-0″ octagon. P = 68.819 kips, E = 3.153 ft., k = 0.25 for 15′-0″ octagon.

$$D = \sqrt{64.0/59.949 \times 14.0^2} = 14.47 \text{ ft., say 14.5 ft., and}$$

$$E = 14.5/14 \times 2.943 = 3.06 \text{ ft.}$$

Step 4—Check assumed foundation weights:

Pier:	5′-0″ octagon 3′-6″ high	= 10.87 kips
Foundation:	14′-6″ octagon 1′-6″ thick	= 39.20 kips
Backfill:	(174.1 — 20.7) x 2.5 x 0.1	= 38.40 kips
	Total	= 88.47 kips

$$P = 235.0 + 88.47 = 323.47 \text{ kips}$$

$$E = \frac{990.0}{323.47} = 3.06 \text{ ft.}$$

$$\text{"Adjusted" } P = \frac{323.47}{5.0} = 64.69 \text{ kips}$$

$$D = \sqrt{64.69/59.949 \times 14.0^2} = 14.62 \text{ ft.}$$

Since k = 0.25, it is immediately known that 25 percent of the diameter of the octagon is unloaded and 75 percent is loaded; the unit soil pressure varies from 0 on the windward side to 5,000 lbs. per sq. ft. on the leeward side over the loaded length.

Problem 3. This problem illustrates use of tables to determine soil loading under an existing foundation. For this problem, refer to Figure 3 and use the following data:

$P_v = 300$ kips, weight of tower
$M = 373$ ft.-kips
$D = 11'\text{-}0''$, diameter of octagon

In the solution of this problem, the following relationship is used:

$$\frac{p_1}{1.0} = \frac{P_1}{P} \text{ or } p_1 = \frac{P_1}{P} \text{ for a given "k" or "m" value.}$$

When p_1 = actual maximum unit soil pressure,
P_1 = total vertical load,
P = Table 1 octagon load capacity based on 1.0 kips per square foot soil pressure.

Step 1—Calculate weight of pier, foundation, and earth back-fill:

Pier:	5′-0″ octagon 3′-6″ high	= 10.87 kips
Foundation:	11′-0″ octagon 1′-6″ thick	= 22.50 kips
Back-fill:	(100.2 — 20.7) x 2.5 x 0.1	= 19.88 kips
	Total	= 53.25 kips

Step 2—Calculate total load and eccentricity:

$$\text{Total load} = 300.0 + 53.25 = 353.25 \text{ kips.}$$

$$E = \frac{373.0}{353.25} = 1.06 \text{ ft.}$$

Step 3—Enter Table 1 for 11′-0″ octagon with known "E." Read P = 59.102 kips.

$$m = 0.15.$$

$$p_1 = \frac{353.25}{59.102} = 5.98 \text{ kips/sq. ft. (5,980 lbs. per sq. ft.), on leeward edge.}$$

Minimum soil pressure $mp_1 = 0.15 \times 5980 = 897.0$ lbs. per sq. ft. on windward edge. 100 percent of footing is under compression.

The method outlined herein has been limited to octagon foundations for brevity. Using appropriate formulas[2], the same method may be applied to square foundations with an overturning moment about both the rectangular and diagonal axes.

LITERATURE CITED

[1] Fork, Chas. A., "Graphical Methods Aid in Stack Foundation Design" Petroleum Refiner 30, No. 3, p 81 (1951).

[2] Fork, Chas. A., "Applying Graphical Methods to Square Footing Design" Petroleum Refiner 31, No. 11, p 145 (1952).

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David H. Kannapell is a senior structural engineer with Girdler Construction Corp., Louisville, Ky. where he performs civil and structural design of gas processing and chemical plants. Holder of a B.S. degree in civil engineering from the University of Louisville (1936), Kannapell has had structural design experience in many large chemical plants, synthetic ammonia, hydrogen production, gas purification and carbide manufacturing plants. He is currently the president of the Louisville chapter of the Kentucky Society of Professional Engineers.

Applied Hydrocarbon Thermodynamics

Part 21: Nomographs and Convergence Pressure Correlations of Vapor Liquid K-Values

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FROM THE PREVIOUS discussions of the thermodynamics of phase equilibria in Part 18, of the generalizations of fugacity coefficients in Part 19, and of the PTC K-charts in Part 20, it is evident that the correlation and prediction of the equilibrium vapor-liquid phase distribution ratios for hydrocarbon mixtures is a very complex subject.

The limitations of theoretical and generalized correlation methods frequently makes it necessary to make experimental determinations of the vapor-liquid K-values for mixtures and conditions of interest. Sometimes such data can be used to obtain the coefficients of semi-theoretical equations. Frequently, it is more practical to develop completely empirical correlations with the new observed K-values plus all the available data from the technical literature.

Besides plots of log K vs 1/T, for lines of constant pressure, or plots of log K vs log P, with lines of constant temperature, two other empirical techniques are frequently used for hydrocarbons, namely: nomographs and convergence pressures. By the use of alignment charts or nomographs, more compact empirical correlations of vapor-liquid K-values may be obtained. The effect of composition on the K values of the components of hydrocarbon mixtures can frequently be represented by the convergence pressure, which has been used with the log K vs log P and the nomographic correlations. Both of these empirical correlating techniques are discussed in this installment.

Convergence Pressure Concept. The convergence pressure concept for correlating K-values is based on an observed critical phenomena of binary mixtures, which is illustrated on Figure 21.1 for five hydrocarbon binaries. In Figure 21.1, the left half and the right half have a common scale, namely pressure. In the left part temperature is the other coordinate while in the right the other coordinate is the K-value.

Vapor pressure curves for any two components, such as methane and *n*-pentane, and the locus of the critical pressures for mixtures of these two components defines

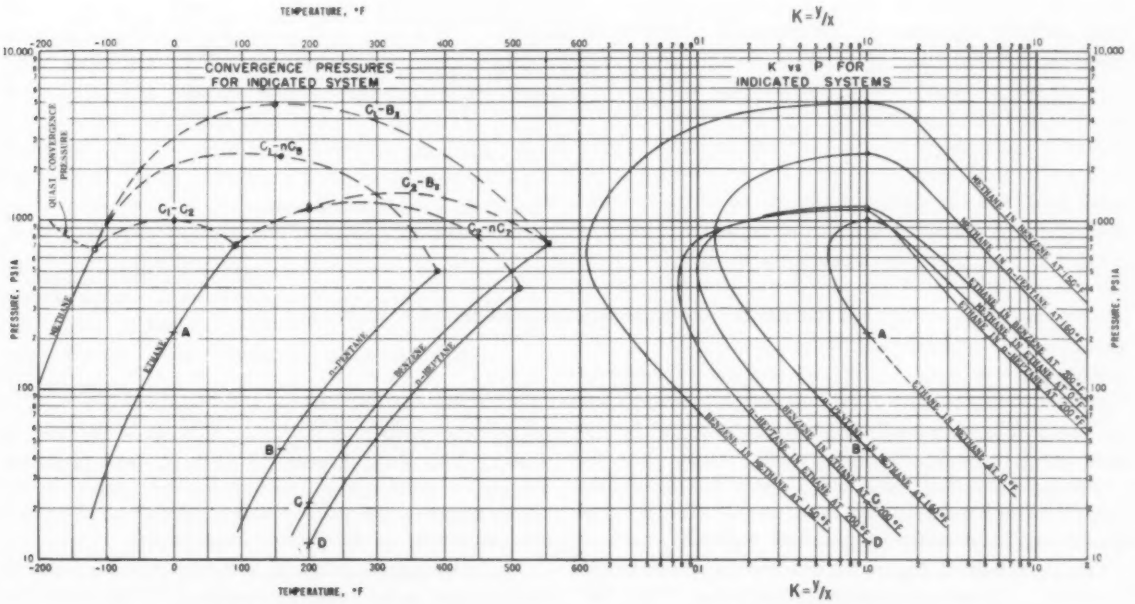

FIGURE 21.1—Convergence pressure concept for vapor-liquid K correlations.

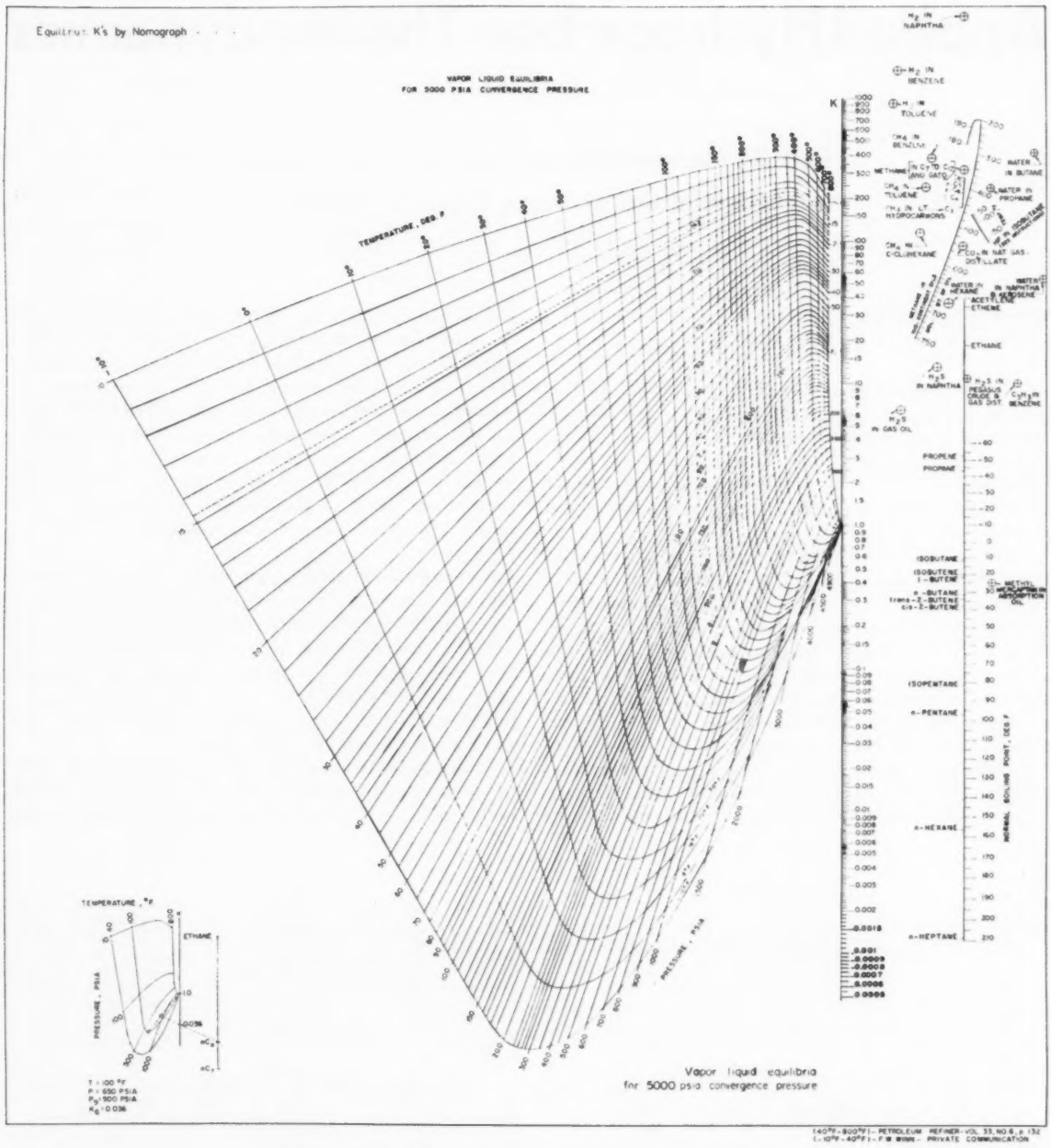

FIGURE 21.2—Winn nomograph (Courtesy of F. W. Winn).

the phase boundaries for these different mixtures. In other words, the area bounded by the vapor pressure curves and the critical locus is the two-phase region. All possible two-phase mixtures of these two components will be in this pressure-temperature region.

The right half of Figure 21.1 shows the vapor-liquid K-value vs pressure at constant temperature. When the K-values for both light and heavy components of a binary are plotted in this way, a loop is formed, as shown. This loop crosses $K=1.0$ at two pressures, namely the convergence pressure for the mixture at the system temperature and the vapor pressure of the heavier component at the system temperature.

The convergence pressure, at which $K=1.0$ for both components, is the critical pressure of the mixture (the same two components) that has a critical temperature

equivalent to the system temperature. This is illustrated on Figure 21.1.

Another point of interest is that the heavy component K curve should not be continued to K_s above unity when plotting for actual binaries.

Phase boundaries and typical K value isotherms are shown in Figure 21.1 for five hydrocarbon binary mixtures. These were plotted from observed data, the sources of which are given by the indicated references: methane-ethane,[22] methane-*n*-pentane,[25] methane-benzene,[4] ethane-*n*-heptane,[11] and ethane-benzene.[12]

The K-value isotherms on Figure 21.1 show that the convergence pressure is a very effective correlating parameter but has its limitation, as can be seen by the two ethane curves for 200° F. The convergence pressures of the ethane-benzene and the ethane-n-heptane are essentially the same at 200° F but the K-value of ethane in benzene is about 60 percent greater than its value in n-heptane.

The definition of convergence pressure for a binary as "the critical pressure of the mixture having a critical temperature equal to the system temperature" works fine when the system temperature is between the critical temperatures of the two components. In this region convergence pressure has a physical significance. This is shown graphically by the critical loci curves in the left half of Figure 20.1.

K-value isotherms for temperatures lower than the lowest critical temperature of a binary also converge, forming loops similar to those at higher temperatures. For these cases a quasi-convergence pressure has been suggested by Hadden[7] and included in P_k charts by Lenoir and White.[16] This idea is illustrated on Figure 20.1 for mixtures of methane as the lowest boiling component. Further discussion will be included in the review of the Braun publications later.

The need for quasi-convergence pressures is more frequently encountered for mixtures having no very low boilers, like methane, however. Such a mixture would be n-pentane and n-heptane at 350° F, for example. For such a mixture the convergence pressure technique would not be at its best advantage.

The definition and application of convergence pressure to multicomponent systems requires treating the multicomponent mixture as a hypothetical binary while estimating the convergence pressure for estimating the K-values. Different techniques have been proposed for handling mixtures of this type. These will be discussed with the reviews of different contributions that follow later in this installment.

Nomographs. There are four main types of K-value nomographs, identified by their parallel scales and grids along with the authors and references, as follows:

Type	Parallel Scales	Grid	Authors	References
I	P and T	C_n and K	Scheibel and Jenny DePriester	26
II	T and K	C_n and P	Hadden	5
III	K and C_n	P and T	Winn	29
IV	K_{10} and K	P and P_k	Lenoir et al	13, 14, 16, 17
			Hipkin	8

Type I nomographs include no composition parameter. DePriester[3] proposed his nomograph as a first approximation for use with his PTC K-charts. This type of nomograph is most convenient in use because only one setting of a straight edge on the system temperature and pressure is required for all K readings.

Along with his Type II nomograph, Hadden[5] presented composition effect correction factors which were functions of the molal average boiling point.

Convergence pressure was not included in either Type I or Type II nomographs, but this correlating parameter was incorporated in Types III and IV, however. Winn[29] constructed his nomograph for a P_k of 5,000 so that all K values converged to unity at a pressure of 5,000 psia. The latest version of this Winn nomograph is republished here as Figure 21.2.

The Winn nomograph was applied at other than 5,000 P_k values by using an auxiliary correlation giving *Grid Pressure* as a function of *Convergence Pressure* and *System Pressure*.

Type IV is the Braun K nomograph, which was developed by Lenoir et al.[8, 13, 14, 16, 17] In this correlation the variables are grouped so that the K-value is a function of the K_{10} (K-value at 10 psia) value and the system and convergence pressures. The K_{10} is a function of temperature only for each hydrocarbon. More details will be given later.

Convergence Pressure Background. A review of the publications of nine groups of authors on this K value correlation technique should aid in the readers' understanding of this subject. These previous publications will be given in chronological order.

In 1933 Katz and Brown[9] pointed out that the required information for predicting the K-value of any component at a given temperature and pressure included: molecular weight, critical temperature and vapor pressure of the compound and the critical point of the mixture. They also said that K is unity for a component when its vapor pressure is equal to the system pressure and that the value of K for each and every component in a mixture is equal to unity at the critical point of the mixture. Although the convergence pressure concept, as it is now known, was not defined by these authors, they did state the basic principles for it.

Katz and Hachmuth[10] showed in 1937 the variation with pressure of the vapor-liquid equilibrium constant for hydrocarbons in crude oil—natural gas systems, using actual phase equilibria measurements. These pressure effects were shown in log K vs log P scales, one chart for each temperature, with the curves for each hydrocarbon all intersecting the $K=1.0$ line at a pressure above the pressure of the highest measurement.

From their experimental investigations of the phase equilibria of narrow cut petroleum fractions, White and Brown[27] showed, in 1942, the convergence phenomena for hydrocarbons from pentane up to 725° F boiling point. They also showed the critical low curves of a furnace oil and a naphtha. Using these data and previously published data, these authors then correlated the minimum K-value for the higher boiling components with vapor pressure and convergence pressure.

In 1952 and 1953 three convergence pressure type K-value correlations were published. These had been

presented in Phase Equilibria Symposia held at AIChE meetings in 1949 through 1952. The papers by Rzasa et al,[23] Organick and Brown,[19] Hadden,[6] and Winn[29] will be reviewed in the order they appeared, including some later work by Organick.[20, 21]

Rzasa et al[23] developed a correlation for predicting the convergence pressure of systems containing methane or natural gas with complex hydrocarbon mixtures ranging from natural gasoline to crude oil. The resulting correlation gave the convergence pressure as a function of temperature and the product of the molecular weight and the specific gravity of the heptanes plus fraction.

Organick and Brown[19] developed an empirical correlation of the convergence pressure type for the equilibrium volatility ratios. In this correlation the convergence pressure is found from the molal average boiling point of the equilibrium phase and the average molecular weight of the equilibrium liquid. Organick's method of finding the convergence pressure is a trial and error procedure, which is a disadvantage. On the other hand it avoids the uncertainty of representing the mixture by a hypothetical binary for the estimation of the convergence pressures from the critical loci curves.

Recently, Organick and Hollingsworth[21] presented a machine method for computing the convergence pressure of methane containing mixtures. In this method P_k is found as function of system temperature and the critical temperature of the hypothetical heavy component in the equilibrium liquid phase.

Hadden[6] showed that the convergence pressure is a function of the liquid phase composition excluding the concentration of the lightest component. In addition, Hadden introduced the concept of the quasi-convergence pressure for vapor-liquid equilibria at temperatures below the critical temperature of the lightest component.

K Nomographs using the P_k Concept. As mentioned earlier there are two vapor-liquid K-value nomographic correlations that use the convergence pressure concept. These are the charts by Winn[29] and Lenoir et al.[13, 14, 15, 16] These are of such interest that the latest versions of them are reprinted here. These will be described with reference to these charts which are Figures 21.2 through 21.12.

Figure 21.2 is the Winn nomograph and Figure 21.3 is the grid pressure relationship. These are revisions of the original charts, in the following respect: The grid of the nomograph was extended to lower temperature and the Figure 21.3 for estimating the grid pressure was revised. By these two charts five variables are correlated. These are: the component or its boiling

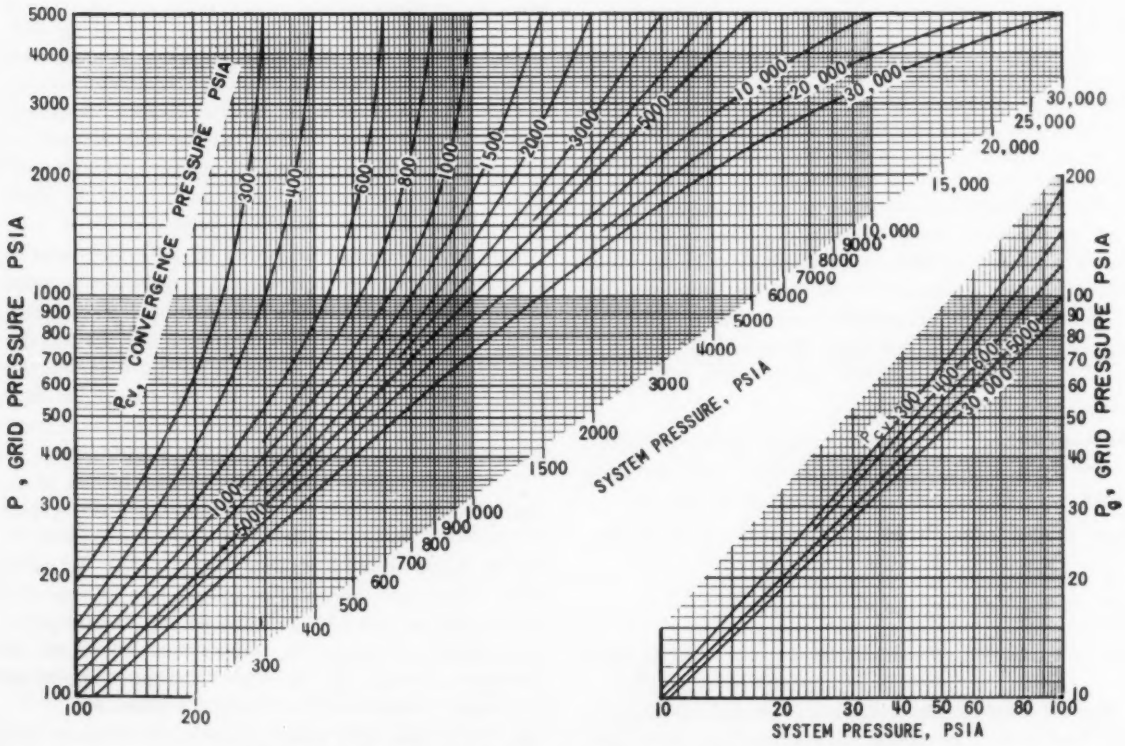

FIGURE 21.3—Grid pressure for Winn nomograph (Courtesy of F. W. Winn).

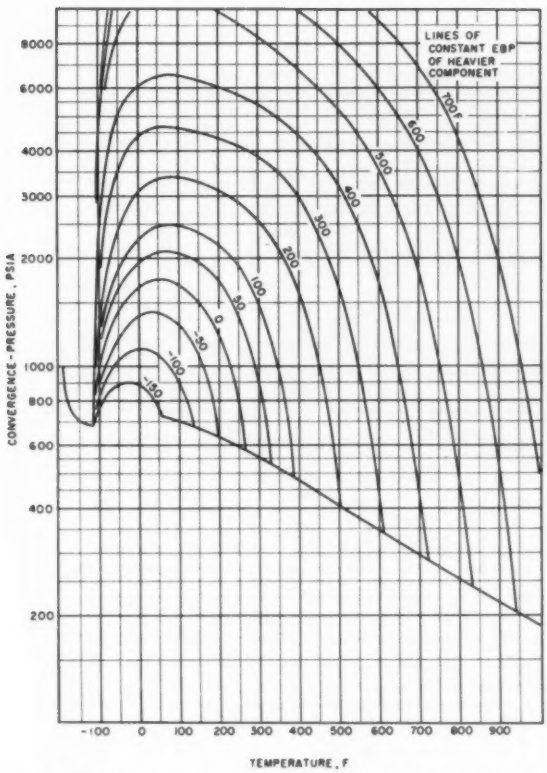

FIGURE 21.4—Convergence pressure, lighter component EBP = —259° F. (Braun Correlation).

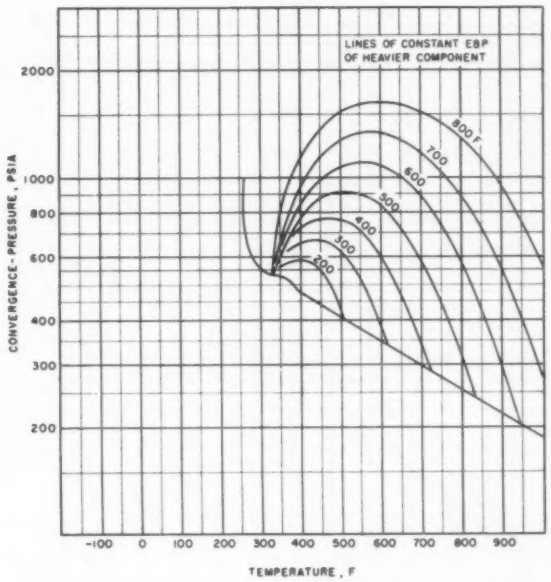

FIGURE 21.5—Convergence pressure, lighter component EBP = 50° F. (Braun Correlation).

point, the K ratio, the temperature, the pressure, and the convergence pressure. A sixth variable, the character of the liquid phase, is also included for special systems. This is a very compact presentation of vapor-liquid K ratios. As originally published this nomograph had 40° F as its lower limit. The author has since extended the chart to —10° F. This latest version is the one reproduced here.

The component range is H_2 to *n*-heptane with a normal boiling point scale for hydrocarbons not identified by name. The top of this scale is 210° F, this limit being determined by the physical limitations of reproduction. Winn illustrated how the component scale could be extended into the higher boiling region, using the same pressure-temperature grid.

The parallel K and boiling point scales are drawn and the K scale is marked off in logarithm spacing Boiling points are found for the other scales by using the following relationship at several temperature and pressure conditions, arbitrarily chosen to cover the desired range.

$$\frac{K_H}{K_7} = \left(\frac{K_2}{K_7}\right)^b \qquad (21.1)$$

where:

K_H = y/x for heavy component
K_7 = y/x for C_7
K_2 = y/x for C_2
b = volatility exponent

Typical values of b for different boiling point petroleum fractions:

BP °F	Value of b
300	0.27
400	0.70
500	1.22
600	1.82
700	2.70

Winn evaluated his nomograph for a total of 965 data points, which included several non-hydrocarbon systems such as: water-hydrocarbon, HF in *i*-butane, H_2S in oil, CO_2 in Natural gas, N_2 in octane, and H_2 in aromatics. The standard deviation for all points is 9.4 percent.

The Braun K ratio method is included in this discussion to illustrate another technique for predicting vapor-liquid K-values. This method is based upon the use of an intermediate parameter, K_{10}, which is the vapor-liquid equilibrium ratio at the system temperature and 10 psia for the hydrocarbon in question. By means of this intermediate parameter the variables affecting the K-value have been factored so that

$$K_{10} = \text{function (T, component)} \qquad (21.2)$$

$$K = \text{Function of } (K_{10}, P \text{ and } P_g) \qquad (21.3)$$

note: the symbol P_g is used instead of P_K for convergence pressure in this correlation.

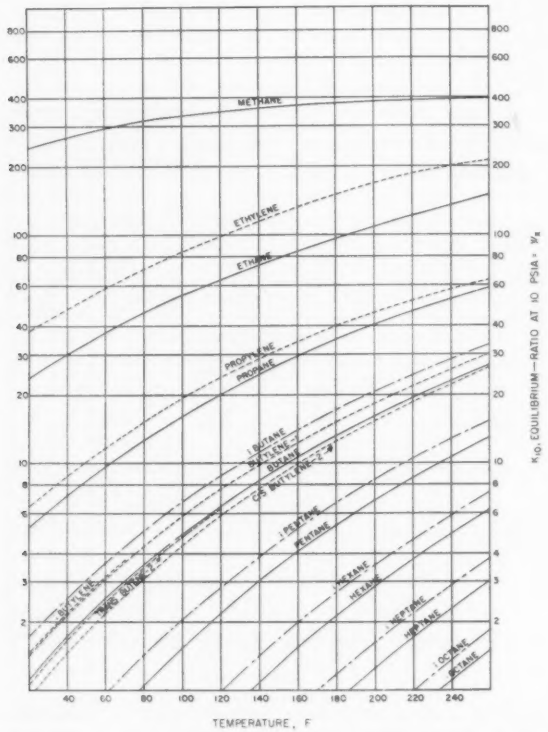

FIGURE 21.6—Equilibrium ratios at 10 psia aliphatic hydrocarbons: 20° to 260° F. (Braun Correlation).

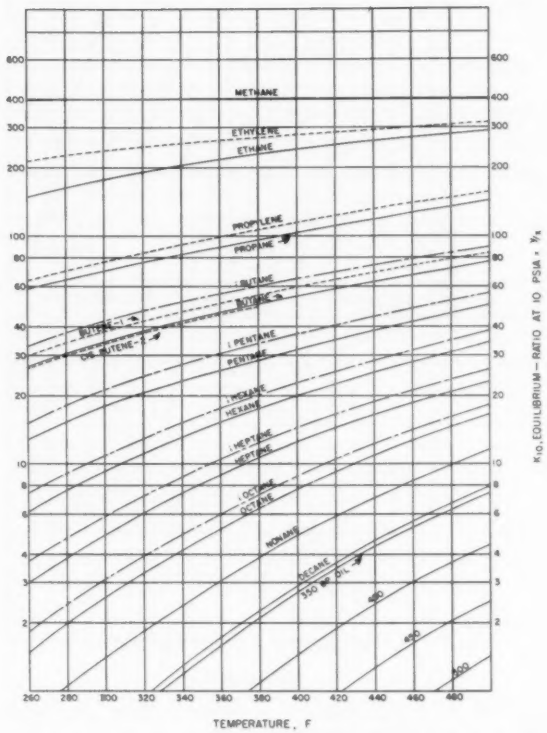

FIGURE 21.7—Equilibrium ratios at 10 psia aliphatic hydrocarbons: 260° to 500° F.

This method has been described by Lenoir and coworkers.[8, 13, 14, 16, 17] Figures 21.4 through 21.9 are copies of part of the charts presented recently by Hipkin.[8] These illustrate the method. Figures 21.4 and 21.5 are two of the 11 charts recommended for finding the convergence pressure. Figures 21.6 and 12.7 are two of the 14 charts recommended for estimating the value of K_{10}. Figures 21.8 and 21.9 are the nomographs, each covering different pressure ranges i.e. 10 to 500 on Figure 21.8 and 150 to 1,000 on Figure 21.9.

In developing this nomograph the authors made use of the fact that straight lines were obtained when K-values are plotted against K_{10} values for constant pressure and convergence pressure. This lead to the simple relationship

$$K = \beta K_{10}^{\alpha} \qquad (21.4)$$

or

$$\log K = \alpha \log K_{10} + \log \beta$$

where: α and β are functions only of pressure and convergence pressure.

The K_{10} concept and the procedure used in developing the Braun correlation are equivalent to saying that the K vs P curves of all substances having the same convergence pressure and the same K_{10} values (different temperatures for each substance) will be congruent.

Hipkin[8] reports an average arithmetic deviation of 4.6 per cent and a statistical deviation of 6.2 per cent for the latest version of the Braun correlation. Myers and Lenoir[17] compared an earlier version with the NGAA,[18] Rzasa et al[23] and Winn[28] and found deviations of 6.8 percent, 7.7 percent, and 9.0 percent for the same data that the Braun correlation gave 6.2 percent. The ranges of these data were: 40° to 500° F and P_K from 1,000 to 8,500 psia.

NGAA Charts. From tabulations of K ratios developed by the late G. G. Brown in the work described by Organick and Brown,[19] a set of convergence pressure K charts were prepared and published under the supervision of a special committee of the NGAA.

These charts covered 12 hydrocarbons plus some other gases and nine convergence pressures. Separate charts were prepard for each hydrocarbon at each convergence pressure. A total of 132 charts was prepared by the Fluor Corporation from the tabulated values of K. Publication was via the NGSMA Technical Data Book.[18]

It is of interest to examine the NGAA curves to see how well they follow the K_{10} concept. The following values from the NGAA curves for normal paraffins at P_K of 5,000 psia show rather substantial departures from congruency at the higher pressures.

From this rather superficial examination one can only conclude that the NGAA charts do not fit the Braun correlation scheme. Both correlations have been shown

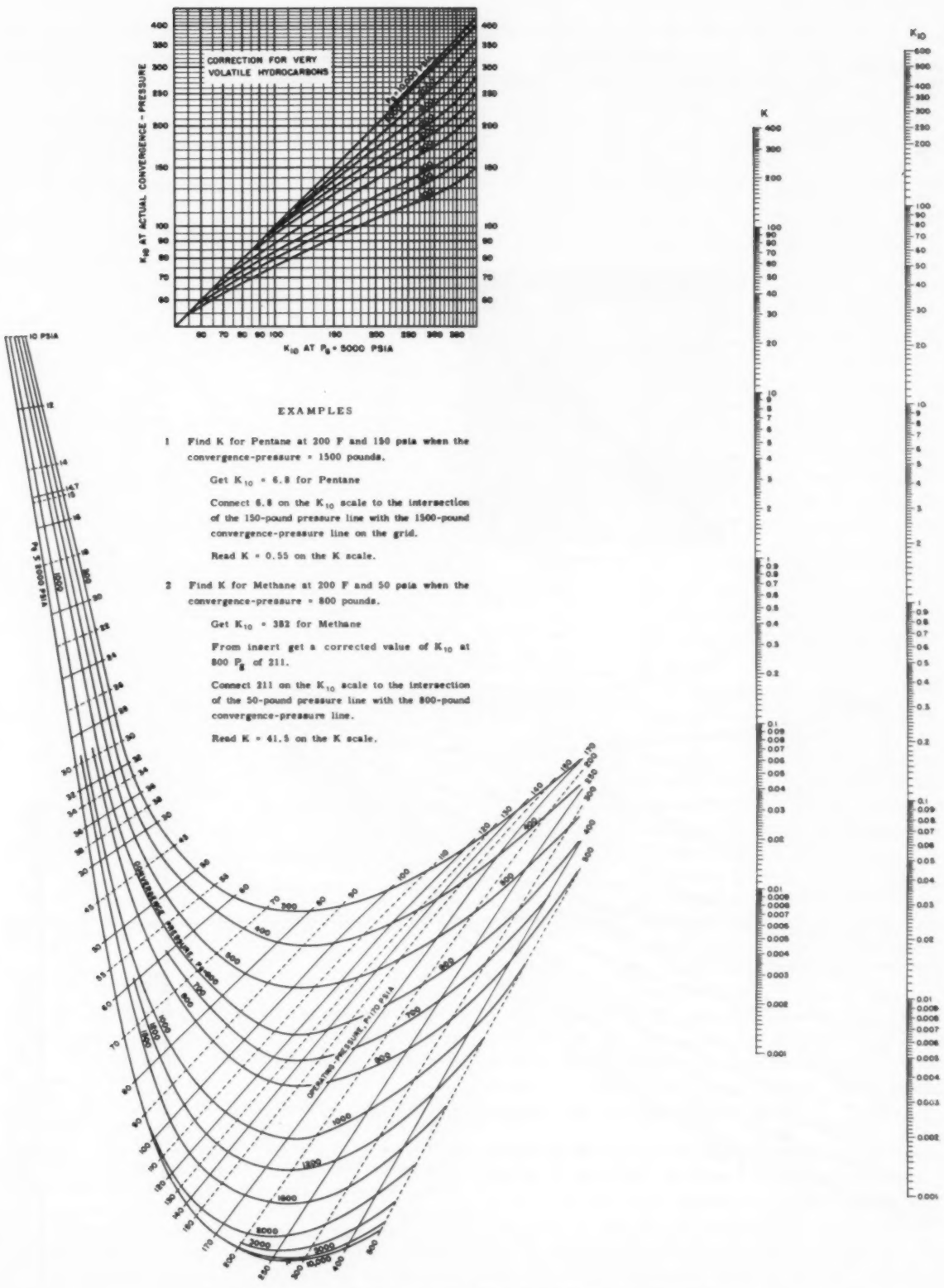
CORRECTION FOR VERY VOLATILE HYDROCARBONS
K_{10} AT ACTUAL CONVERGENCE - PRESSURE
K_{10} AT P_s = 5000 PSIA
EXAMPLES
1 Find K for Pentane at 200 F and 150 psia when the convergence-pressure = 1500 pounds.
Get K_{10} = 6.8 for Pentane
Connect 6.8 on the K_{10} scale to the intersection of the 150-pound pressure line with the 1500-pound convergence-pressure line on the grid.
Read K = 0.55 on the K scale.
2 Find K for Methane at 200 F and 50 psia when the convergence-pressure = 800 pounds.
Get K_{10} = 382 for Methane
From insert get a corrected value of K_{10} at 800 P_s of 211.
Connect 211 on the K_{10} scale to the intersection of the 50-pound pressure line with the 800-pound convergence-pressure line.
Read K = 41.5 on the K scale.
10 PSIA
CONVERGENCE PRESSURE, PSIA
OPERATING PRESSURE, PSIG PSIA
K
K_{10}

FIGURE 21.8—K-value nomograph 10 to 500 psia. (Braun Correlation)

P_K = 5000 psia HC	T °F	NGAA K VALUES AT 10 psia	100 psia	600 psai
C_1	−235	5	0.40	0.110
C_2	− 72	5	0.64	0.213
C_3	102	5	0.58	0.178
C_6	250	5	0.68	0.260
C_8	365	5	0.62	0.175
C_{10}	460	5	0.57	0.160

to be fairly reliable representations of the experimental data on which they were based. No more definite conclusions will be reached.

Hinshaw Charts. A recent set of convergence pressure type K charts that is of interest was prepared by Hinshaw,[7] working with G. G. Brown. The objective of this work was an improved set of K ratio charts that

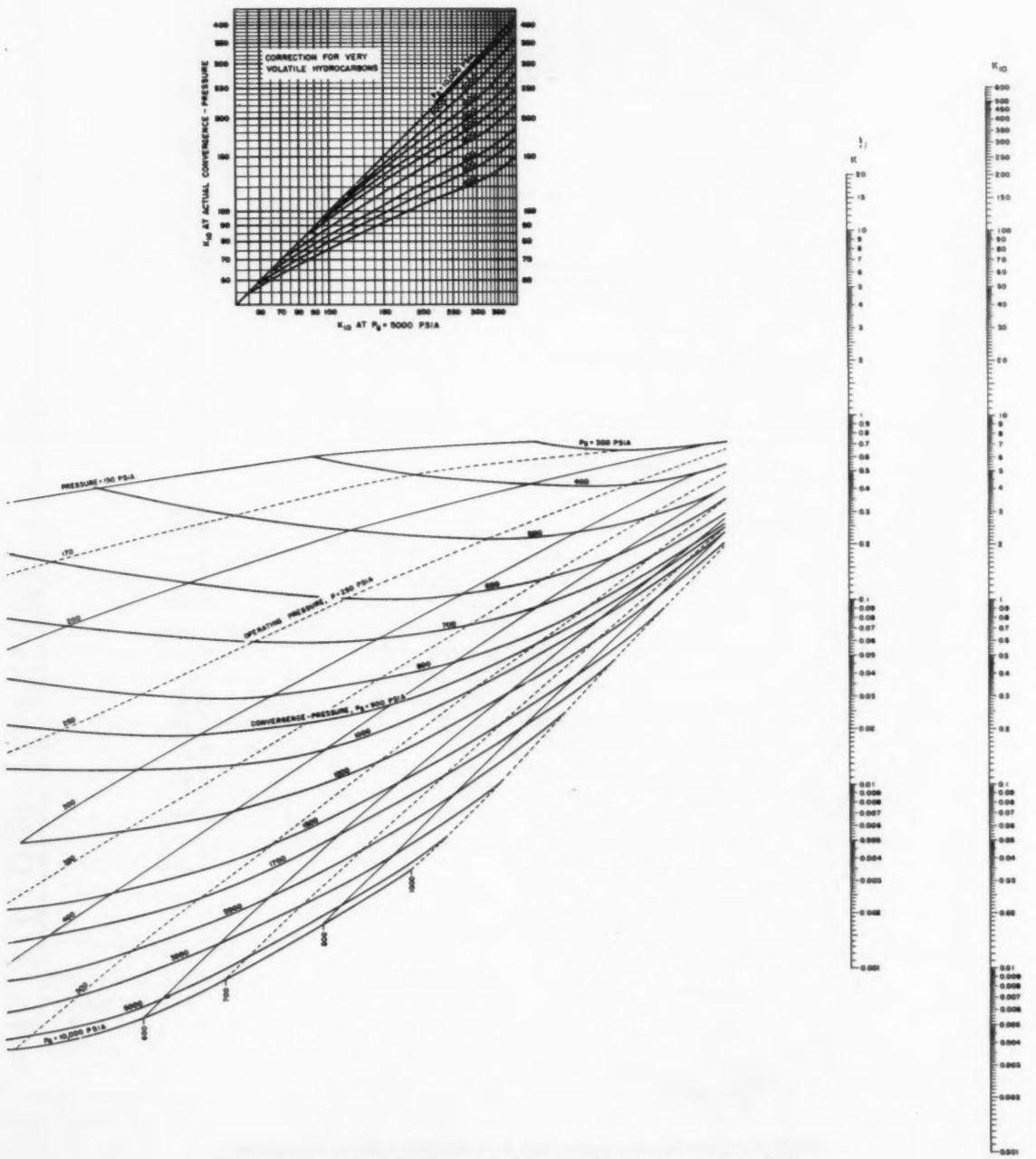
CORRECTION FOR VERY VOLATILE HYDROCARBONS
K AT ACTUAL CONVERGENCE - PRESSURE
K AT P = 5000 PSIA
PRESSURE - 150 PSIA
OPERATING PRESSURE, P = 250 PSIA
CONVERGENCE - PRESSURE, P = 500 PSIA
P = 10,000 PSIA
K

FIGURE 21.9—K-value nomograph 150 to 1,000 psia. (Braun Correlation)

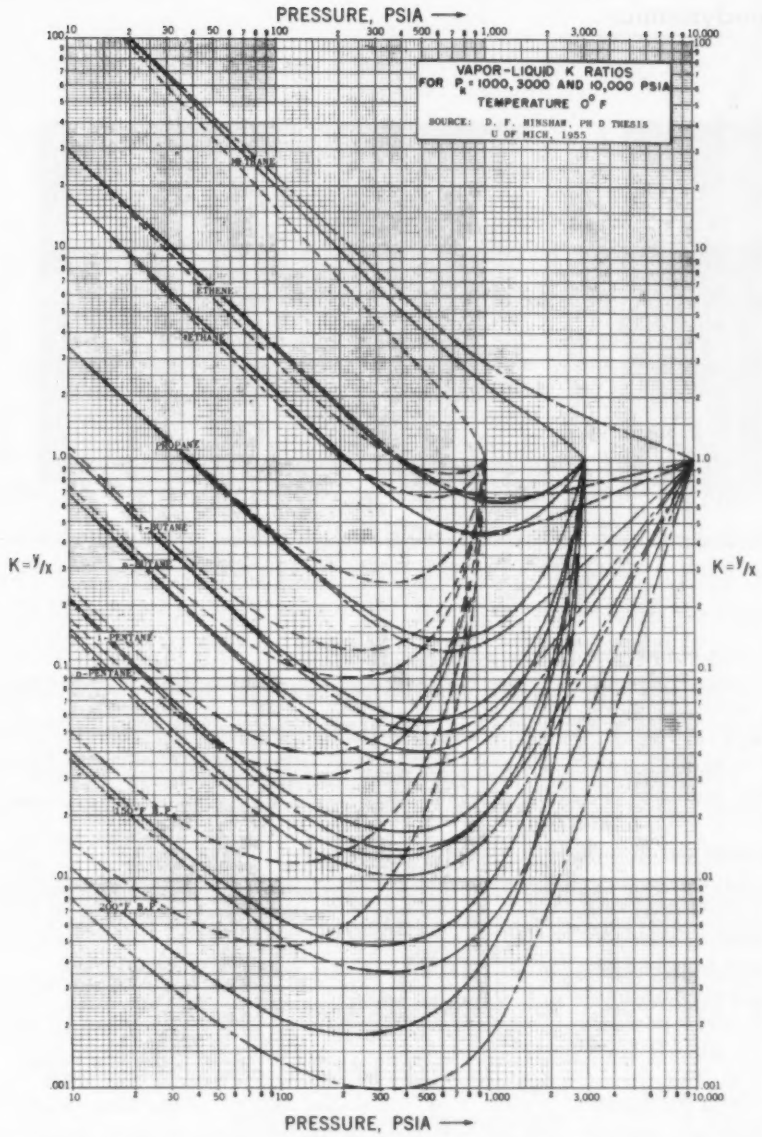

FIGURE 21.10—Replot of Hinshaw's K-values at P = 1,000, 3,000, and 10,000 and K at 0° F.

were for aliphatic hydrocarbons only and that covered a wide range of hydrocarbons. Such a correlation could serve as an ideal systems basis in developing correlations for other mixtures.

With this objective in mind Hinshaw concentrated his correlation work on methane-paraffin binaries. Organick, who had preceded Hinshaw in this work at the University of Michigan, had included other data so that his correlation has some deviations from paraffinic systems built into it, which leads to some inconsistencies. Hinshaw developed a new method for finding P_K, which Hinshaw calls "correlating" pressure instead of "convergence" pressure, in addition to the K ratio charts.

The Hinshaw K charts cover the following ranges:

P_K : 400 to 16,000 psia
P : 14.7 to P_K
Temperatures: —175 to 700° F
Components: Methane to 750° F b.p.

Equilibrium ratios were plotted on log-log scales with K and P as the coordinates. A separate plot was made for each temperature, at 100° F intervals, and each correlating pressure.

Figures 21.10 through 21.14* were prepared from the Hinshaw plots, using the ratios for P_K values of 1,000, 3,000, and 10,000. The entire boiling point range is not included due to space limitations. These composite plots illustrate the effect of correlating pressure on the K ratios.

Interpolations are required with either these replots or with Hinshaw's originals for intermediate values of temperature and correlating pressure. This can be done graphically on log K vs T and log K vs log P_K scales. Hinshaw claimed an average deviation of 3 percent for all available data on methane in paraffin systems. For mixtures containing naphthenes and aromatics an average absolute deviation of 8 percent is claimed.

In using these K ratio charts, Hinshaw recommends finding P_K from an empirical correlation using three variables: (1) molar average boiling point of the equilibrium vapor phase, (2) the weighted average molecular weight of the equilibrium liquid, and (3) the equilibrium pressure. The correlation is graphical and is applied by trial and error, first assuming P_K and then going through up to seven charts, including several corrections, to find the P_K indicated by the system conditions.

A preliminary separation calculation is required for any unknown mixture to get a first estimate of the compositions of the equilibrium vapor and liquid to get the required MABP of vapor and MW of liquid, before applying this P_K estimation method.

Shape of K Curves at High P_K Values. An examination of the NGAA K charts[18] at various convergence pressures shows what appears to be an inconsistency. The shape of the K vs P isotherms for the 10,000 and 20,000 convergence pressures for all hydrocarbons differs very much from the shape of the corresponding

* Only Figure 21.10 is included in this paper. Figures 21.11, 21.12, 21.13 and 21.14 (at 100°, 300° and 400° F) will be included in Professor Edmister's book which will be available after Part 25 appears.

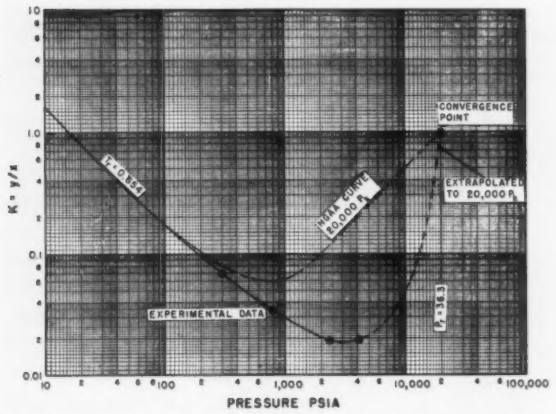

FIGURE 21.15—K-values of n-Butane in hydrogen mixtures at 40° F.

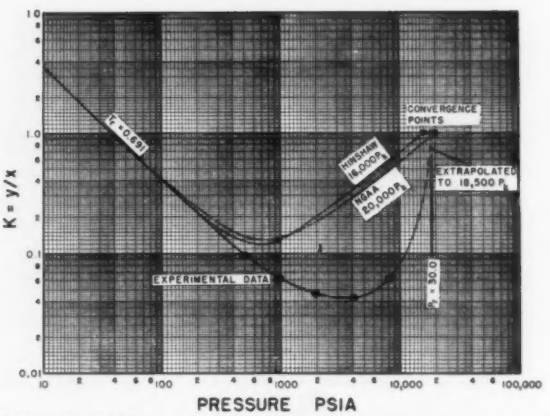

FIGURE 21.16—K-values of propane in hydrogen mixtures at 0° F.

curves at the lower convergence pressures. Convergence pressures in the 10,000 to 20,000 psia range are only encountered with mixtures containing methane, nitrogen, and hydrogen. Methane mixtures, especially methane binaries, were used in the Organick-Brown[19] work that led to the NGAA charts and also in Hinshaw's[7] work.

With the exception of the Rzasa-Katz[24] data on Methane-Kensol,[16] all of the systems for the original data had convergence pressures below 10,000 psia.

Data on two hydrogen-paraffin binaries, namely H_2-nC_4H_{10} and H_2-C_3H_8, are available.[1, 28] The K-values for *n*-butane at 40° F in the hydrogen mixture are plotted in Figure 12.15. The convergence pressure was estimated by the method of Lenoir and Hipkin[14] to be 20,000 psia for this system at 40° F. The experimental data curve is extrapolated to K=1 at P=20,000 on Figure 21.15 and the NGAA K curve for *n*-butane at 40° F and 20,000 P_K is drawn on Figure 21.15.

As can be seen, there is a very substantial difference between these two curves at pressures above 1,000 psia. For convenient reference, the *n*-butane reduced conditions corresponding to 40° F and 20,000 psia are shown on Figure 21.15.

A similar comparison is given on Figure 21.16 for propane in hydrogen mixtures at 0° F, for which the convergence pressure by the Lenoir-Hipkin[14] method is 18,500 psia. In addition to the NGAA curve for propane at 0° F and 20,000 P_K, the Hinshaw curve for propane at 0° F and 16,000 P_K is shown. (16,000 P_K is as high as Hinshaw carried his correlation.)

From the comparisons shown on Figures 21.15 and 21.16, it is obvious that these high P_K curves need revising. To a lesser degree, the Rzasa-Katz data on Methane-Kenzol[16] shows the same trend for a convergence pressure of P_K=10,000.

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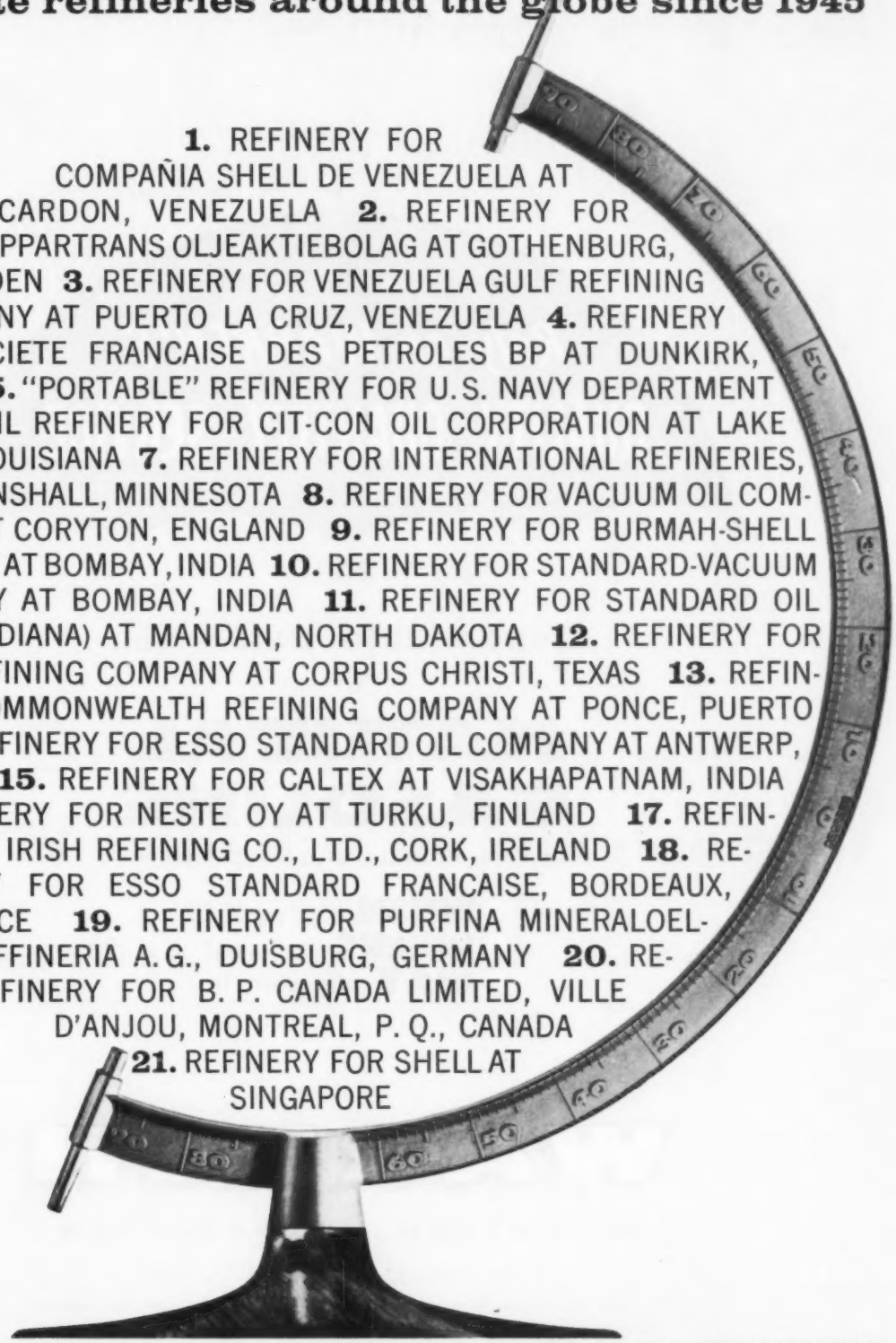

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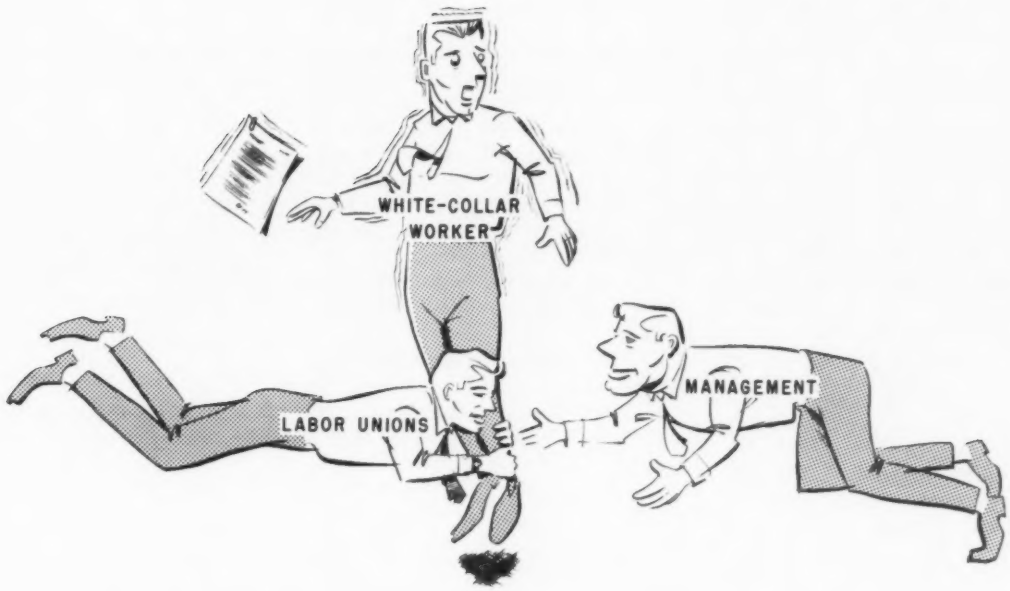


White Collar Unionization— Challenge to Management

Management should consider the five main reasons why white collar workers are willing to join a union, and sometimes even seek out labor organizers

James J. Bambrick
The Standard Oil Co. (Ohio), Cleveland

TWO GROUPS are primarily interested in white-collar unionization. These are the unions from the standpoint of how to organize them, and employers from the standpoint of how to take care of their needs so as to make unionization unlikely.

First, let us dwell briefly on how and why unions organize white-collar workers. Howard Coughlin, president of the AFL Office Employees International Union very succinctly explained to a National Industrial Conference Board audience why they, as businessmen, were going to be terrifically interested in the subject of his talk. In essence he told his audience:

"You are not interested in the subject of white-collar unionization as such. Rather, you're interested in how not to have white-collar unionization. You are going to take all my remarks on how and why white-collar workers organize and put a reverse twist on them so as to get hints on how not to have your workers organized. You're betting that you, individually, will do the right thing in time so you won't have white-collar unionization. I'm betting that there are thousands of businessmen who won't do the right thing in time, and we will have white-collar unionization."

That, in simple terms, is the status of interest of this phase of the subject. Much the same thing has been said

by many other leaders of white-collar unions.

Why Unions are Trying. Unions are hitting into the field of white-collar unionization for three reasons:

1. Many in unions feel that with a couple of million dollars, and the right circumstances, that they could duplicate the organizing sweeps that occurred in the 1930s. For this eventuality they are educating their organizers. For example, industrial unions, which many believe will do the main job of white-collar organizing, have spent a great deal of time on the techniques for organizing white-collar workers. And the type of organizer they are hiring differs greatly from the prototype of yesteryear.

They are hiring a new type—college graduates, accountants, bookkeepers, engineers, office supervisors. To give you an example, I met one of my former NYU students—a man with a Master's degree—at the national headquarters of a union. I asked him what he was doing there. He told me he was in charge of white-collar organizing for a midwestern city. He noticed that I always wore vests and asked me where I got my suits. He told me that he likewise always wore vests and that he found that the only place he could get suits with vests was in Brooks Brothers. Imagine, the new type of union organizer: a good-looking, educated, cultured man in a Brooks Brothers suit.

2. The second reason why unions are hitting into the field of white-collar unionization is that they are studying the statistics on the number of white-collar versus blue-collar workers. In April of 1956, the Bureau of the Census announced a turning point in the history of the United States, the number of white-collar workers exceeded the number of blue-collar workers. By 1965 the Bureau of Labor Statistics expects there to be 31.3 million white-collar workers versus 28 million blue-collar workers.[1]

However, look at the percent of unionization of these two groups. Of the 24 million blue-collar work force, unions have organized almost two-thirds, or slightly more than 15 million workers. Of the 28 million white-collar workers they have organized about 2.5 million or less than 10 percent.[2] Union leaders feel they must organize the unorganized 90 percent of the white-collar work force or die.

3. The third reasons is that not only are unions losing membership relative to the total population, but they are now losing membership in absolute numbers. BLS analysis dated December of 1959 showed that in 1956 unions in the United States had 18.5 million members, and that in 1958 they had 18.1 million members.[3] Thus while population was increasing, union membership declined 400,000 members.

Union leaders feel they must organize white-collar workers or become a minority element in setting wages, in community life and in politics. However, if they do organize the white-collar worker, they will change the whole political complexion of the country. They point to European countries where the unionized white-collar worker supplies the intellectuals and the radicals of the Labor or Socialist parties.

In the United States the white-collar worker is the backbone of the Republican party. What would he be if he was unionized?

Management's Strengths. Management faces the problem of possible white-collar unionization in a strong position. For under ordinary circumstances, there is perhaps no more pro-management group than its white-collar work force. And up to the recent times he has been hard to organize. Why?

1. The white-collar worker, instinctively associates himself with management. Recognition by management, a promotion, a pat on the back from the big boss, mean a great deal to him.

2. He considers himself superior to the manual worker and feels that unions are strictly for blue-collar workers and not for him.

3. He abhors the violence that comes with striking. To many the thought of striking is anathema.

So much for management's strengths. But now look at the weaknesses and ask: Why do union leaders consider this difficult-to-organize group as perhaps ripe for unionization?

For an answer we have to go to what research has shown to be four main reasons why white-collar workers in some companies have unionized.

1. They were discontent over their earnings and over their economic position.

2. They lacked a sense of security. They felt they had no guarantee that they would not be laid off out of turn arbitrarily and capriciously.

3. These white-collar workers lacked a sense of justice. They felt that they lacked just handling of day-to-day grievances—that their supervisors' word was law from which there was no appeal.

4. They felt a lack of recognition by the company and the community for the importance of the work they were doing.

5. Above all, they lacked any method whereby they could communicate with their employers concerning these and the many other reasons why a particular group organizes. Studies of already-unionized places show they were organized for, what seemed to the employers involved, the most trivial of reasons and which—had they known about it—could have been cleared up in a short while. But what was missing was communication. By the time these employers did know about them, the deed was already done—their places were unionized.

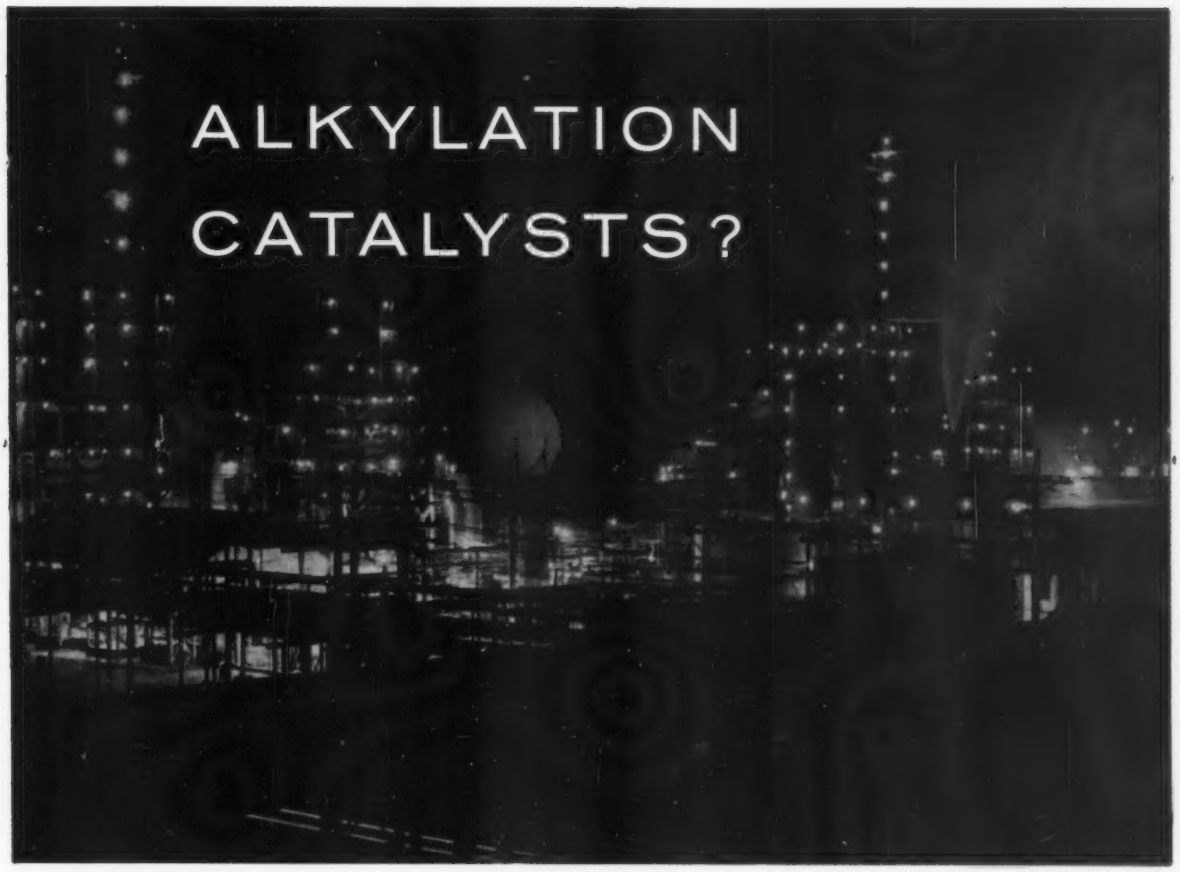
Now, let's discuss each of these in more detail.

1. ECONOMIC REASONS

White-collar workers were long unorganizable because they enjoyed a wage differential over their unionized blue-collar brothers. From 1890 to 1920 this differential was 50 percent to 100 percent greater. By 1929, however, it had been cut to 28 percent, and by 1954 it was 2 percent *less.*[4]

These are country averages. When it comes to specific industries, the figures are even more startling. For instance the last steel settlement provided a minimum of more than $4,000 a year to a sweeper.

Fringe Benefits. At one time white-collar workers enjoyed many fringe benefits and the blue-collar workers enjoyed none. However, during the wage freeze of World War II, blue-



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collar unions started to push for fringe benefits. They got paid holidays and vacations. After the war they got insurance, hospitalization and pensions.

Thus, the fringe benefit gap between unionized blue-collar and unorganized white-collar workers has steadily narrowed. As blue-collar workers achieve parity with white-collar workers in fringe benefits, it means that relatively the white-collar worker is losing ground. Some firms try to overcome this by making sure that every time they give some fringe benefit to their organized blue-collar workers, they give something of like value to their unorganized white-collar workers.

Tandem Increases. Another dollars-and-cents reason why some white-collar workers join unions is the refusal of some employers to give their white-collar employes a tandem increase when they grant across-the-board increases to their blue-collar workers. In order to understand why this causes white-collar unionization, it is necessary to deal with the why of tandem increases.

Because of America's high-pressure salesmanship, many workers are in a financial hole. Only the annual increase that they have come to expect can bring their noses above water. The union leaders knowing that, each year demand and frequently get an increase. Thus, the question here is this: If that is true for the blue-collar worker is it not also true for the white-collar worker? And if so, is it not sometimes even more so for the white-collar worker?

What happens if a company doesn't give a tandem increase? Here's an actual example: A multi-plant firm with a plant in Illinois bargained and gave 10 cents an hour to its production workers. The corporation's industrial relations director begged the manager of the Illinois plant to give a tandem increase to the white-collar employes.

The Division Manager said, "No. We'll wait until the aniversary of each employe's employment date, and we will then decide whether each such person shall get an increase or not."

A month later the industrial relations director got a call to hurry out there. The white-collar workers resented the double standard and were asking the production union to sign them up. On the bathroom walls they wrote: "They got theirs, what do we have to do to get ours—unionize?" Needless to say, the company gave them a tandem increase in a few days.

The second type of tandem increase is that given to predominantly white-collar groups. Here's an example of what I mean:

In the Spring of 1955 there was a big white-collar unionization drive among the banks and insurance companies in the New York area. In August of 1955 when employes of banks in the Wall Street area picked up their inter-office phones to answer a call, instead of saying, "Hello," they said "Did you get yours?" They were referring to an 8 percent increase in salary that was given almost simultaneously by many of the major New York banks. A similar increase was granted by a number of the large insurance companies.

One bank official gave the following as the bank's reasoning for the 8 percent increase:

"We compared the increases our employes received since World War II to those received by one of the country's largest industrial firms. We found

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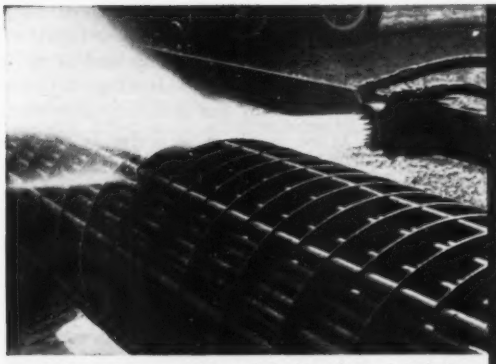
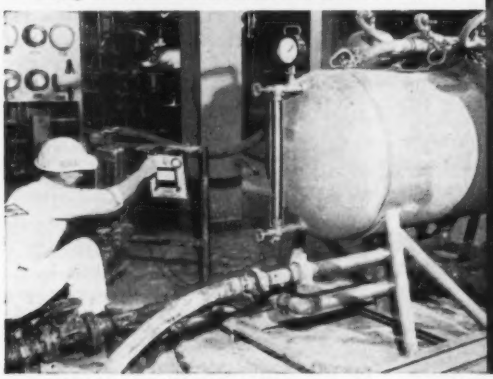


Jetting tool cleans tubes fouled with coke and asphalt.



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Industrial Cleaning. Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

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You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio. *TRADEMARK

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that their employes climbed the economic ladder 8 percent faster than our employes. In giving this increase all we did was let our employes catch up. It was a delayed tandem increase."

This delayed tandem increase also ended the 1955 white-collar unionization threat among New York banks and insurance companies and there hasn't been any serious threat since.

Tandem Plus Merit. I want to make one thing clear. The firms that give tandem increases don't do so in lieu of merit increases. They give tandem increases *plus* merit increases. Here's their reasoning:

1. The tandem increase is given because of changes in the cost-of-living plus general increase in the nation's over-all productivity.

2. Merit increases are purely individual. Some people get them and some don't. They are given because of a person's ability to do a particular job has improved. That person is actually doing a better or more efficient job than he or she previously did.

3. Merit increases don't cost anything if a firm has proper salary administration and a normal distribution in each salary grade. Here's why. Some employes are coming in at the bottom of the salary grade; others are going out at the top to the next grade because their abilities have improved. You have equal number of employes on both sides of the salary grade mid-point. (If you don't, and have the distribution skewed too much on the high side or low side, something is wrong.) Since the average of any salary grade will be the mid-point, you end up with merit increases not costing anything. The key is that you feed people in at the low end to offset those being merit increased or promoted at the high end.

Telescoping. The fourth financial reason for white-collar unionization is the telescoping. Telescoping—sometimes called compression—is pushing up the bottom or entering rate while not making similar adjusments in salaries in the intermediate and top brackets. It leads to unionization because it causes discontent. I would like to give a practical example.

Engineering is the field in which telescoping has had its greatest effect. In 1934, engineers with a year's experience got a median salary of $1,139.[5] Now what do they get? About $6,000 a year according to Dr. Frank S. Endicott's latest survey.[6] The jump from a $1,139 one-year rate to a $6,000 hiring rate is a 535 percent increase.

Now let's take the man with 14-17 years' service. In 1934 he got a median salary of $2,977 a year.[7] Does he now enjoy five-and-a-third times as much, or about $16,000 a year? Rather, according to the latest figures of the Engineers Joint Council, the man with 15-years' experience got a median salary of between $9,100 and $10,000 a year during 1958.[8] That's one evidence of telescoping.

Another way of looking at it is: In 1934 the salary ratio of the man with 14-17 years' experience over the beginner was 2.6 to 1. Now the salary ratio of the man with 15 years' service to the boy just out of college is about 1.6 to 1.[9] That's another evidence of telescoping.

Telescoping causes discontent, especially with the older employe. He sees the salary paid his entering job, which he regards as his measuring job, get closer and closer to his present salary. He feels that relative to his entering job he is just standing still or losing ground.

White-collar union organizers point out that it is not always the young hothead who organizes, but it is frequently the old sage in the office or drafting room who does the most effective organizing. When, "good old John," who's discontent over telescoping, signs up, he takes more than just himself into the union.

Many in management feel that the way to meet telescoping is to restore the salary ratios that used to exist before business began wildly bidding up entering rates in office and engineering jobs. Many organizations have made studies of the various ways this can be accomplished.[10]

So much for the dollars-and-cents reasons. Let us now look at the non-financial reasons.

2. NO SENSE OF SECURITY

White-collar workers have organized because they felt that they had no written guarantee that they would not be laid off arbitrarily and capriciously. I know of one case where office workers traveled in a motor caravan 90 miles in the dead of night to wake an office union organizer and beg him to take them into the union. The person who caused this was a new office manager, who arbitrarily and capriciously laid off two office workers. One, a man with 22 years' of service and the other, a woman with 25 years' service. The new office manager threw fear into the hearts of other workers and they sought as a partial guarantee of security—a union contract with the seniority provision.

Many think of seniority as the exclusive property of the union. But that is not so. Many non-union firms have highly detailed written statements of seniority policy which they completely carry out. The written seniority systems of 69 such non-union firms are given in the study, "Seniority Systems in Non-union Companies."[11] Many of these non-union firms credit their written seniority policies with helping to create among their employes a sense of security.

Business executives point out that the greatest security is provided by the healthy, prosperous firm that is constantly growing. However, as is attested by the railroads, seniority in and of itself may mean little in giving a sense of security. In no industry is seniority as finely developed as in the railroads, and in few industries is there a greater sense of insecurity.

Office Automation. Automation in the office is another factor eliminating the feeling of security of the office worker. In many organizations the clerical workers used to have a feeling greatly akin to civil service—they had a job for life. Now office workers see the work they used to do being taken over by machines, and their placid assurance is gone.

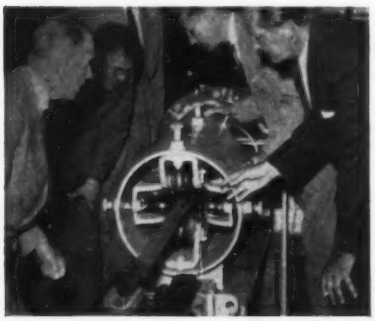
Planning for automation is not merely planning for machines, it is planning for human beings. Long ago the Bell telephone companies decided to go in for automatic equipment throughout the nation. They also made the fundamental decision to gear the introduction of automation with their normal rate of attrition.

Through this human relations preplanning, "Ma Bell" has achieved a high degree of automation. She has thousands fewer employes, and she has had, in the country as a whole, relatively few layoffs. Ma Bell has thus maintained her enviable record of taking care of her own and she has done it along with installing one of the most wide-spread system of white-

ANACONDA CONDENSER AND HEAT EXCHANGER CLINIC

"Cupralum," lead-surfaced Anaconda copper tube, offers practical answers to some tough corrosion problems

If you'd be interested in more compact, more economical heat transfer units for handling corrosive liquors – sulfuric, chromic, phosphoric acids, sulfites, sulfates, alum, and the like – you should know about Cupralum*. Cupralum, a product of Knapp Mills, Inc., is Anaconda copper or copper-alloy tube to which a uniform, dense-structured, extruded chemical lead surfacing has been metallurgically bonded.



Alfred P. Knapp, chairman, Knapp Mills, Inc., explains to visitors how his company's patented drawing process metallurgically bonds lead surfacing to copper tube.

THE OUTSIDE lead surface, which may be from ⅛" to ½" thick, resists concentrations of acids—of sulfuric acid, for example, up to about 85% and up to 428 F. Being bonded to the copper, it expands and contracts with the copper during temperature cycling. Without the metallurgical bond, the lead would creep and eventually fail—an inherent weakness of all-lead tubing.

THE COPPER or copper-alloy tube inside provides strength to make Cupralum self-supporting – and to stand steam pressures up to 150 psi in standard wall thicknesses offered. It also provides its high corrosion resistance internally to cooling waters, steam, and refrigerants.

Most important, copper offers its high heat transfer rate. Because of the metallurgical bond with the lead, the over-all heat transfer rate of Cupralum is high—higher than all-lead tube and higher than that of iron and steel.

THE NET RESULT is that a given heat transfer job can be done with fewer square feet of surface – for a more compact unit. Or it is possible to get increased capacity in present existing space.

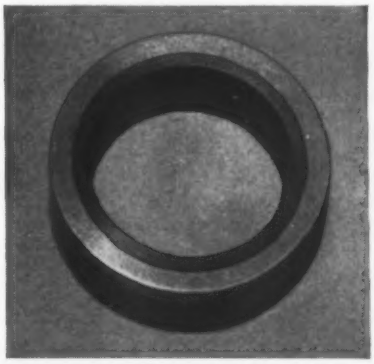
Lead surfacing removed from ends of Cupralum tubes preparatory to insertion in lead-clad steel tube sheet. Tube ends are usually rolled, but for severe thermal cycling service, may be brazed to outer steel face of tube sheet.

Two U-bend Cupralum tube bundles like this are used in a Ferrolum (lead-surfaced steel) separator tower to boil off ammonia from a urea carbonate ammonia solution—in the production of urea fertilizer. Anaconda copper tube core 1" O.D., 12 gauge, handles 150-lb. steam. Lead surface is 3/16 inch thick. Separator tower operates at 145 C (293 F) and 240 psi.

In many cases, the first cost of the coil is lower. Usually this is true where higher steam pressures than those previously used are available—or where expensive, hard-to-fabricate alloys have been used. Improvement of the heating or cooling cycle is another source of savings. Under any circumstances, a long operating life and easy maintenance provide over-all economy.

NUCLEONIC APPLICATIONS. Cupralum with a thicker surfacing of lead is being used increasingly in the nuclear industry. For gamma shields that must be cooled, Cupralum coils are built in to provide efficient heat transfer from the shield to the cooling medium.

Where radioactive liquors and spent resin discharge from demineralizers must be conveyed through process piping into process vessels for concentrating the radioactive solution, Cupralum piping prevents the escape of gamma radiation. In nuclear applications, the lead surfacing may be 1" to 8" thick.



Cutaway section of Cupralum tube. It is produced in 20' lengths or in long continuous coils—from 40' to 100' depending on diameter. It is easy to bend and fabricate. Reliable jointing techniques have been developed.

Lead surfaces of Cupralum tubes and of tube sheet are fused by lead-to-lead welding. Then an extra thickness of lead is applied at the joint for extra protection.

FOR MORE INFORMATION. For detailed data on Cupralum, write Knapp Mills, Inc., Wilmington, Del. Or see your Anaconda representative, who can also provide data on the full line of Anaconda copper and copper-alloy tubes—arrange for technical assistance in meeting special corrosion and heat transfer problems. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6071

*Registered trademark of Knapp Mills, Inc.

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collar automation this country has ever seen.

NO SENSE OF JUSTICE

The second non-financial reason why white-collar workers have joined unions is that they felt that they lacked just handling of their day-to-day grievances. They felt that their supervisors word was law from which there was no appeal. And although they kept quiet for economic reasons, their grievances festered within them and all the time kept growing. In many cases, they openly sought out and bought in the union. Theirs was a case of unionization not from the outside but from the inside.

Union organizers have a ready-made answer for white-collar workers who feel they lack a sense of justice in their dealings with their boss. They say, "Bring in the union and we will establish a grievance procedure such as your unionized blue-collar brothers and sisters have."

Here again unionism and a grievance procedure are thought to be inseparable. And here again research has shown that there are scores of grievance procedures in nonunionized companies. In the book *Grievance Procedures in Nonunionized Companies* are 57 such procedures.[12] Some even include outside arbitration as the final step in the procedure.

The non-union firms covered in this study meant their grievance procedures for real and not for window dressing. The author threw out dozens of non-union companies who claimed to have a grievance procedure and yet had no record of having settled a single grievance under the procedure. There is no such a thing as a sizeable plant or office without a grievance. Grievances are inherent. To deny their existence is ostrich-like. The thing that counts is bringing them out into the open and having them justly settled. The mere fact that an office, engineering department or store happens to be non-union is no reason why employes should be denied the right to just settlement of their grievances. That was the reasoning behind firms that adopted grievance procedures for their non-union employes.

Not Easy. Admittedly, setting up a grievance procedure for non-union groups is difficult and beset with dangers. Under the Cabot Carbon decision,[13] an employer cannot set up an organization that is a union, or acts like a union. Many firms face up to this by having their personnel department handle the preparation of the employe's case and pushing it through the grievance and arbitration steps.

What it boils down to is this: the personnel director in a non-union white-collar situation must, to a certain extent, take on the role that the union would assume. Somebody with guts has to fight for the worker with a real grievance. Somebody has to have the express authority from top management to do so. That somebody cannot be from a weak-kneed school of personnel administration.

Now, that runs somewhat contrary to concept of personnel being a staff function serving line. This concept is a staff function serving the best interests of line.

Instead of setting up a grievance procedure, other firms, such as Eli Lilly, depend upon trained personnel representatives to get the workers' grievance out into the open and get it satisfactorily settled.

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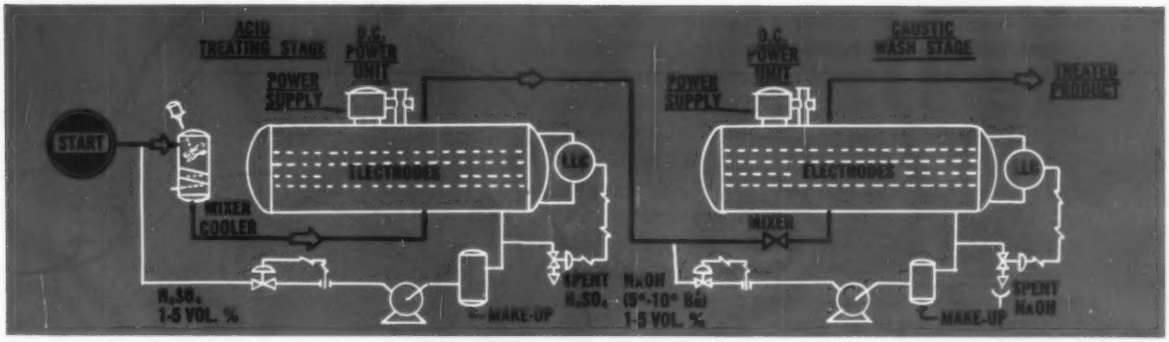


APPLICATION: Reduction of sulfur concentrations in naphtha feed stocks from 0.02 - 1.2 weight percent to 0.002 - 0.005 in the treated products. Successfully applied to sulfur reduction in middle distillates such as kerosene and diesel.

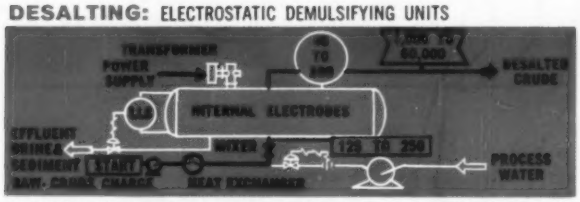
PROCESS: Mechanical (propellor) mixing of acid and oil reduces particle size of the acid to colloidal dimensions for maximized surface area. Entering the electrical field in first treating stage, these particles are violently excited, maximizing random contact with sulfur molecules (electrostatic mixing). Sufficient electrical potential is imposed in the upper portion of the field to enhance random contact of any two acid (or caustic) particles, coalescing them. Reaction is sustained until particles accumulate sufficient mass to fall to the vessel bottom by gravity. Acid carry-over is neutralized in the second treating stage with weak caustic; carry-over of sodium from second stage is warranted not to exceed one ppm. A water wash is frequently employed to assure a perfectly clean product.

PRODUCTION CREDITS: *Carry-Over of Treating Agent* eliminated by electrical coagulation. *Undesirable Side Reactions* (esterification and sulfonation) prevented by ambient reaction temperatures. *Poor Pumpability* of acid due to formation of gummy polymers is prevented by positive pressure (oxygen-free).

ECONOMIC CREDITS: *Total Installed Cost* is about ¼ the cost of hydrodesulfurization units, with substantial reductions when existing vessels can be employed. *Operating Costs* average less than 5 cents per barrel, or about ¼ the cost of hydrodesulfurization, with further reductions if alkylation acid is available. Normal electrical operating load is only 2KVA. *Mechanical Failures* are nil, due to low operating temperatures and pressures, absence of moving parts, "over-designed" electrical components (in terms of normal versus maximum load). *Labor Time* is restricted to one hour per shift for sampling, instrument readings, etc. One annual inspection is adequate. *Yield Losses* are less than 0.5% when treating virgin naphthas.

COMMERCIAL INSTALLATIONS: Three units are currently in operation and about twenty are in the study or design stage. References will be furnished on request. Pilot unit is available for clients at no charge in Howe-Baker's Tyler laboratories.

DESALTING: ELECTROSTATIC DEMULSIFYING UNITS



DESCRIPTION: Process to remove salt and other impurities from crude being charged to distillation equipment.

EQUIPMENT: Electrical equipment in desalting vessel; power supply, instrumentation, etc.

ECONOMIC CREDITS: Economic studies show payouts will vary from low of 50% a year to a high of 250% a year. Minimum credits accruing to refiner from its use: 4.6c/bbl., through increased capacity; 1.1c/bbl., through reduced maintenance; 1.6c/bbl., through improved catalytic and thermal cracking operations; 0.6c/bbl., through reduced corrosion damage; 0.2c/bbl., through increased tank capacity. Total credits: 8.1c per barrel of crude charged.

PROVED: Units now in use have a combined designed capacity of 3.5 million bpsd.

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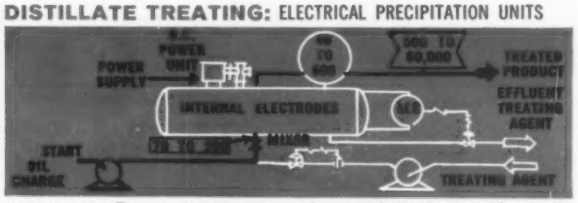

DESCRIPTION: Process to remove treating agent (such as acid, caustic or water) from petroleum distillates.

EQUIPMENT: Electrical equipment in conventional treating vessel; power supply, instrumentation, etc. Frequently, electrical equipment can be installed in existing vessel.

EFFICIENT: Fully automatic and continuous, electrical precipitation drastically reduces carry-over of addition agent . . . lowers chemical consumption . . . eliminates many disadvantages of batch settling.

PROVED: Acceptance by refiners all over the world has been very rapid—over 1.5 million BPD capacity of commercial units sold—an additional 2.5 million BPD under consideration. Send for Howe-Baker's new distillate treating report.

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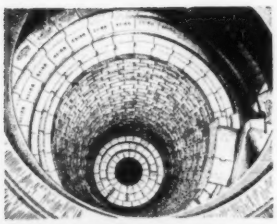

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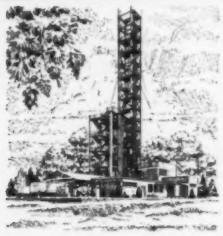

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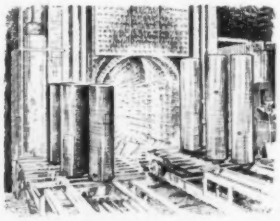

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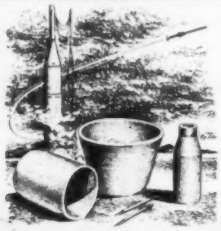

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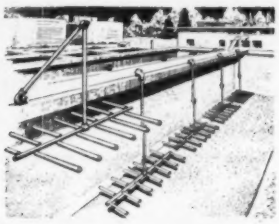

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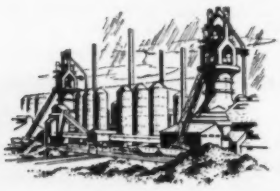

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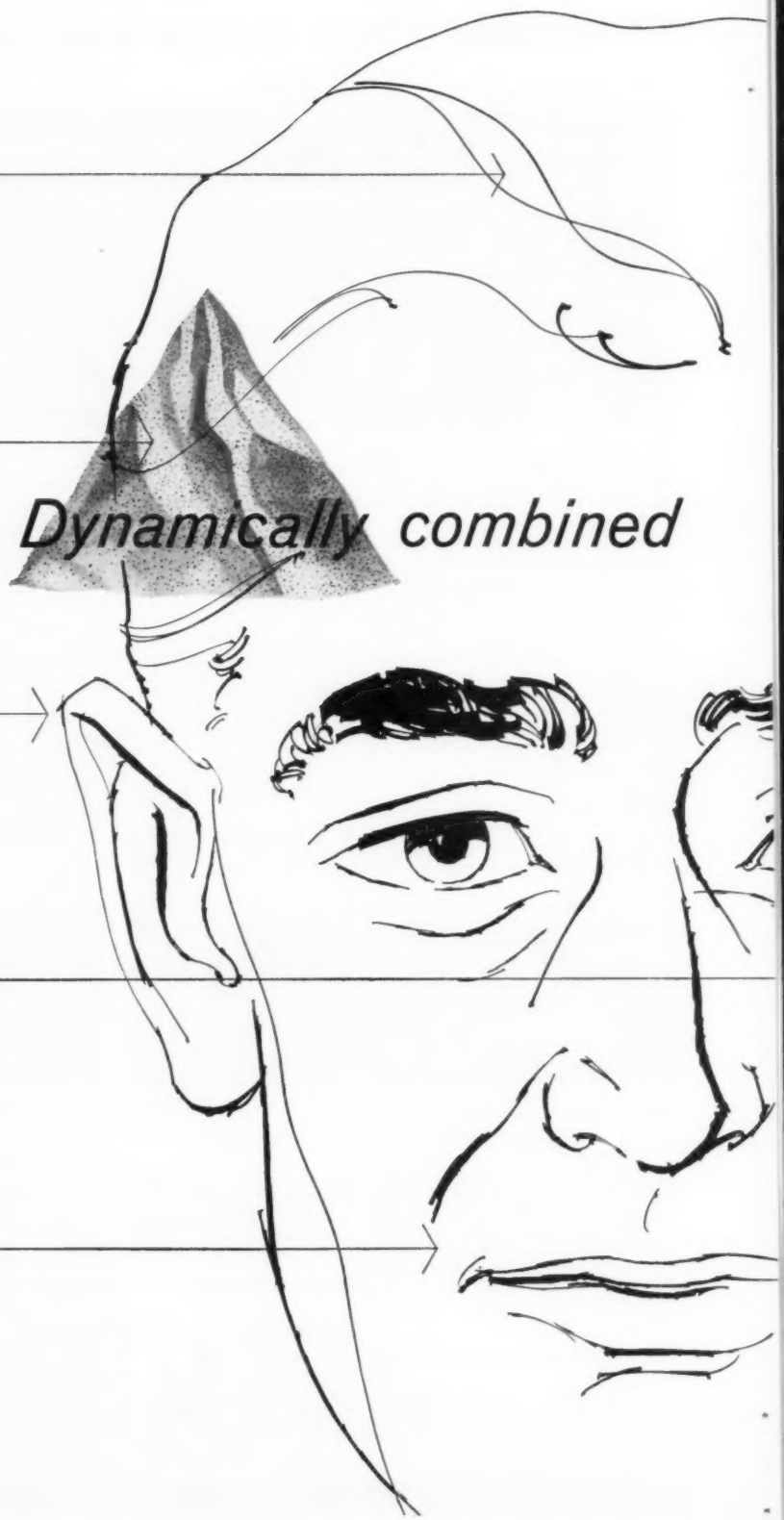

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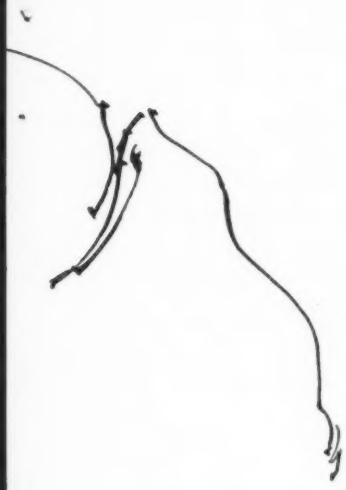

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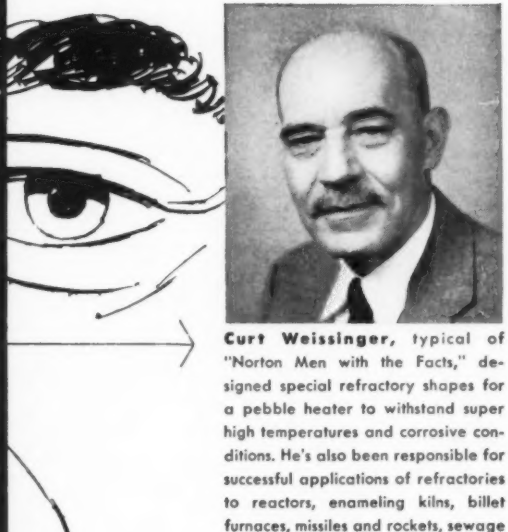

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is used by other firms to get grievances settled. Under this system the onus is on the supervisor to get grievances satisfactorily settled. If he feels a worker's grievance is not satisfactorily settled he is duty bound to bring it to his boss for settlement. And if his boss can't settle it, he likewise is duty bound to bring it to his boss, and so on to chief executive officer. A key element here is a chief executive officer who strongly believes in this system. An organization is but the extension of the shadow of one man—the chief executive officer.

LACK OF RECOGNITION

The third emotional reason why white-collar workers have joined unions is that they felt a lack of recognition of their status. They joined unions because they felt ignored. They felt that the company officials cared naught for what they thought, said or did. They felt that their services were not recognized as important. Strangely enough, that was the reason for the early strikes by engineers. They wanted recognition by management of their professional status.[14]

Other phases of the type of recognition that employes want was shown by an attitude survey that Ford Motor Co. conducted among its white-collar employes. The survey showed that the white-collar workers wanted "recognition of the individual as the good right arm of management—recognition that the employes work is important to the success of the company, that their efforts are appreciated."[15]

LACK OF COMMUNICATION

The fourth emotional reason why white-collar workers have joined unions is that they felt that they lacked any method whereby they could communicate with their employer to let him know what was troubling them.

In the places that were nearly organized, it was obvious that the white-collar workers were organizing for what seemed to the employers involved the most trivial of reasons. Trivial or not, the employers in each case set about clearing up the items that were causing the trouble. When they did so, it quickly became obvious in each case that it was not the items themselves that were important to the workers—it was their inability to communicate upward within the organization that was important. What they really wanted was an opportunity to speak to the boss.

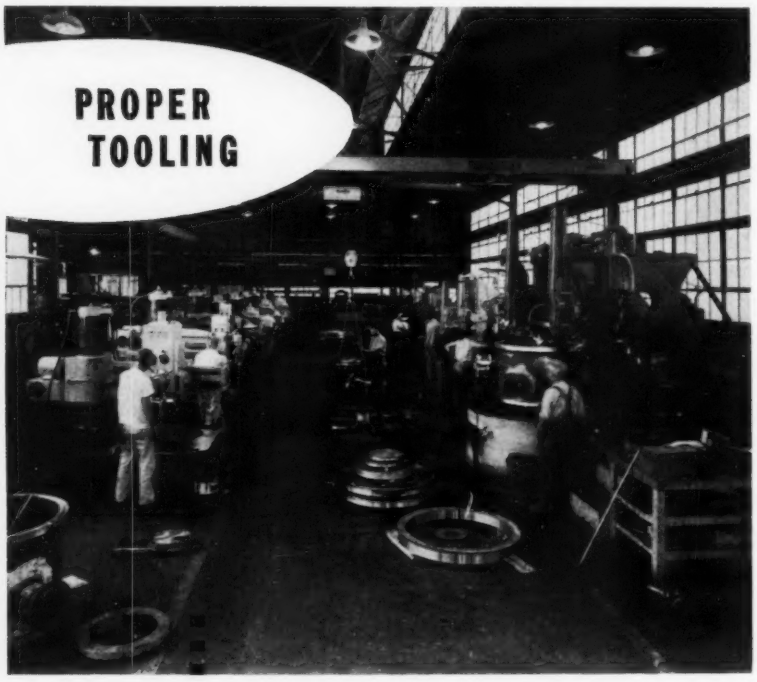
To get this upward communication sometimes all that is necessary is for the boss to sit down and talk with his employes and be ready to listen. In large companies this may be difficult, if not impossible. In such cases other methods are needed. Karlton W. Pierce of Ford Motor Co. says his company has found that the company has found that the employe attitude survey is "an excellent device for upward communication and that it provides a sound and effective means of determining the needs and desires of a company's employes."[16]

WHAT ARE THE ANSWERS?

We have examined five main reasons for white-collar unionization—all of which can be satisfactorily handled by non-union firms. Tom Spates, professor-emeritus at Yale, formery vice-president of General Foods and one of the founders of personnel administration, summed it up this way: "Unions come in when there is a deficiency in management."

We know some of the deficiencies. Let us summarize some of the answers.

1. A written statement of personnel



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policy adhered to at all levels. Such a written policy is the company's contract with the individual employe. It says to him: "These things are guaranteed to you in writing. They will hold true in all our dealings with you. They will not be taken from you arbitrarily and capriciously by some new supervisor."

In place of uncertainty, written policy gives certainty, for it produces the same type of assurance furnished by a union contract. And in other aspects it goes much further and gives assurances that no contract could ever give.

2. A well defined compensation system that puts basic white-collar jobs at rates comparable to those paid blue-collar jobs, and uses job evaluation and salary classification to eliminate telescoping and salary inequities.

3. A written statement of seniority policy that assures the white-collar worker he will not arbitrarily and capriciously be laid off out of turn.

4. A policy and a guaranted-in-writing procedure—observed from the highest to the lowest—for grievance handling.

5. All-pervading communications. Such a concept is more than a communications program, it is a way of life. It covers written and oral communications, and communicating by example. It encompasses communication down the line, up the line, and laterally. It covers all the methods that exist for finding out what is causing discontent.

And, as a way of life, it covers making sure that something constructive is done to clear up the causes of discontent. It makes use of all the techniques of upward communication such as morale surveys, question and answer sessions, foremen meetings, suggestion systems and sounding board organizations.[17] Above all, it requires keeping one's ear to the ground day by day so as to know what's going on.

Last, but not least, is a willingness on the part of the chief executive officer to give his personnel executive the support he needs. If personnel is not so empowered, then it is not unreasonable to suppose that perhaps white-collar employes may empower others to do the job for them.

Another Chance? When personnel executives get together they often get around to this question: "If we could turn back the clock to the early 1930s so our place was nonunionized, and if we were on the scene, had the backing of top management, and had a chance to do it all over again, what would we have done differently? Would that have made unionization unnecessary?

Their answer is generally, "Yes, sound personnel administration applied in time would have made unionization unnecessary in our plants." One of the deans of personnel administration expressed it this way: "We have a chance to do for white-collar workers what should have been done but which we didn't do in time for our blue-collar workers."

How many organizations will pass up that chance?

Originally presented before the management Institute of The University of Wisconsin, April, 1960, this article is based on neither the experience nor necessarily the thinking of The Standard Oil Co. (Ohio). It is based on the composite experience of more than 100 firms which the

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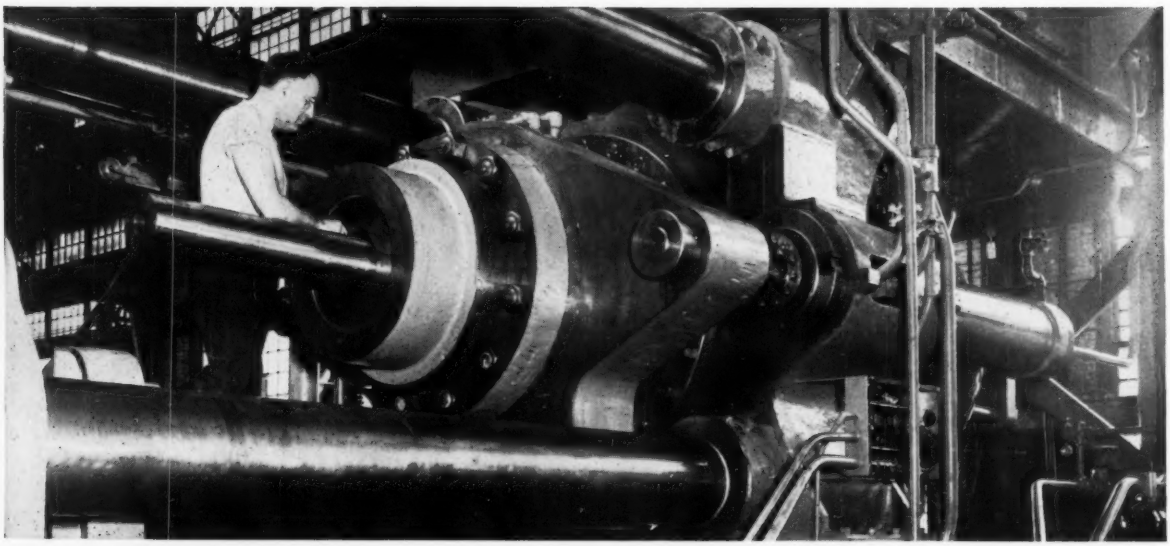

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author interviewed in writing four books and studies on white collar unionization.

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[8] Engineers Joint Council, "Professional Income of Engineers, 1958."

[9] The 1934 ratio is based on Andrew Frazer's study, (loc. cit., p. 132) and are quoted above. The other ratio is based on a comparison of Engineers' Joint Council survey, (op. city.) and Frank S. Endicott's survey, (loc. cit.).

[10] Among the organizations that have done so are the National Society of Professional Engineers (2029 K Street, N.W., Washington 6, D.C.), which has published: "Criteria for Professional Employment of Engineers," 25¢; "Professional Responsibility vs. Collective Bargaining," free; "A Professional Looks at the Engineer in Industry," $3.00; "Recommended Grades, Duties, Responsibilities and Qualifications for Preprofessional and Professional Positions," free. The Engineers Joint Council published in 1956 its study on "Raising Professional Standards and Improving Employment Conditions for Engineers." The July, 1959, issue of the National Office Management Association's magazine *Office Executive* contains many articles dealing with the problem of telescoping. The National Association of Manufacturers, (2 East 48th Street, N.Y. 17, N.Y.), has a number of booklets dealing with this and other phases of white-collar unionization. Among them are, "Satisfying the Salaried Employee," Making an Audit of Salaried Personnel Practices," "Principal Provisions of 20 White-Collar Union Agreements," "A Report to Management on Unionization of Salaried Employees," and "Strengthening Ties with Salaried Employoyees." In addition, there are sections on telescoping in the following National Industrial Conference Board studies by the author: "White-Collar Unionization." NICB, Studies in Personnel Policies, No. 101. "Unionization Among American Engineers," NICB, Studies in Personnel Policies, No. 155; "Engineering Union Contracts," NICB; "White-Collar Union Contracts," NICB.

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About the Author

James J. Bambrick

James J. Bambrick is assistant manager of labor relations for The Standard Oil Co. of Ohio, Cleveland. His professional experience includes personnel direction for All American Aviation, Inc. (now Allegheny Airlines), and for 10 years he was manager of labor relations for the National Industrial Conference Board. A former faculty member of New York University, Mr. Bambrick has been a member of the national panel of arbitrators, American Arbitration Association, since May 1941. He holds BS degrees from New York University and the U.S. Merchant Marine Academy, and an MBA degree from NYU. He has also done graduate work at Wharton School, University of Pennsylvania. Mr. Bambrick is a member of American Economic Association, American Statistical Association, the editorial board of Advanced Management, and the society for the Advancement of Management. He has written 15 books in the fields of labor and industrial relations.

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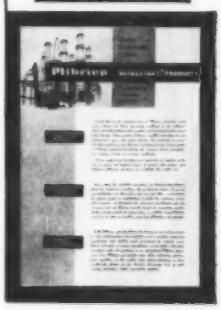

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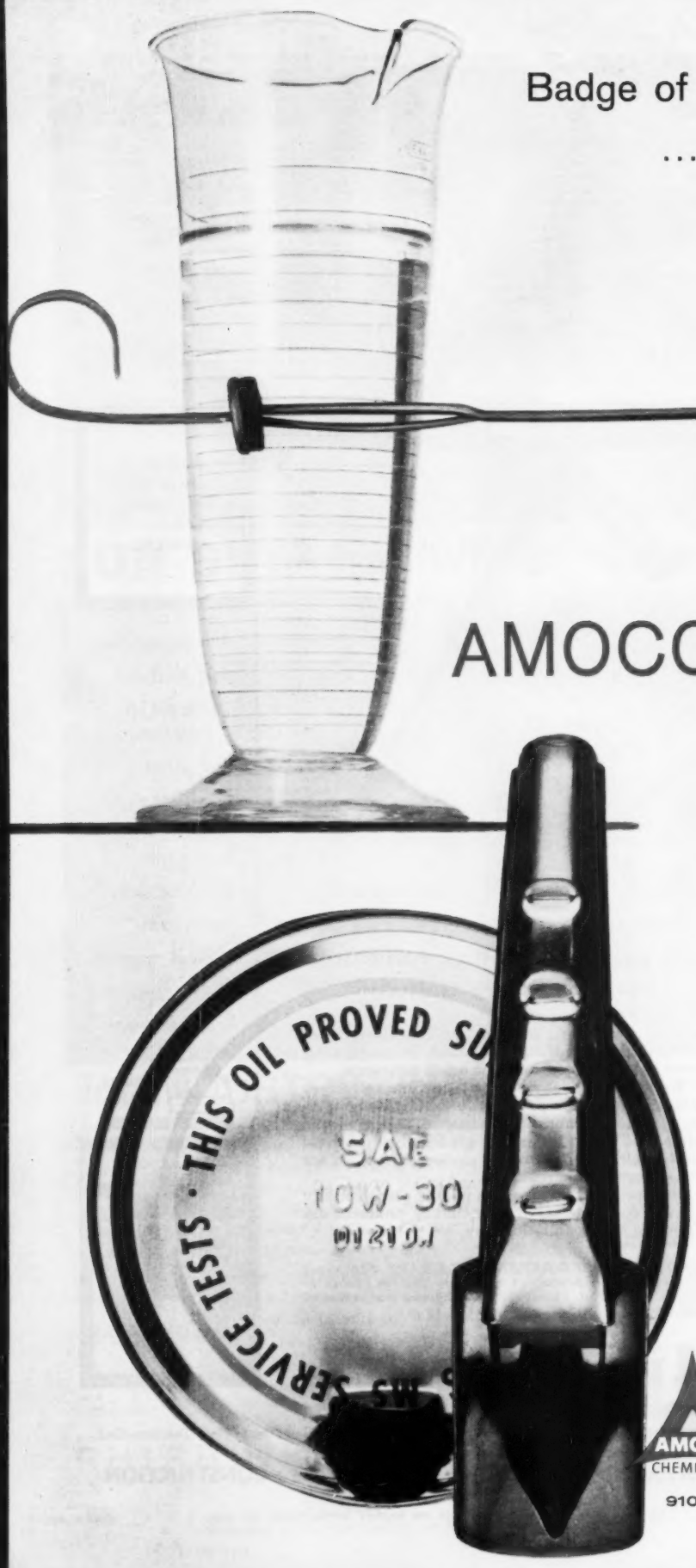

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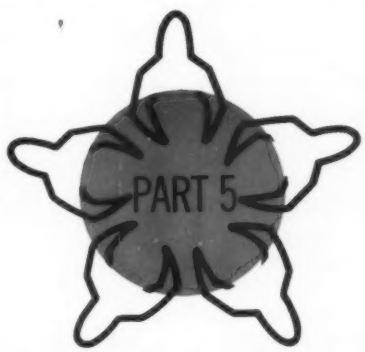
HOW TO GET BETTER DECISIONS FROM GROUPS

To improve group or committee decision-making, members should understand the thought processes involved in reaching a group decision, and the power relationship between its members

Robert R. Blake and Jane S. Mouton
The University of Texas, Austin

HAVE YOU GONE to a staff meeting wishing you could have stayed away? Withheld remarks because you didn't want your knuckles cracked? Resented the fact that the meeting dealt with trivia and ignored the real issues? Put up minor objections to a proposal which were not your real reason for being against something? Made up excuses to leave a meeting early? Seen a staff make a decision which it later had to back down from? Watched a committee start to fall apart because of the time pressures? If you have experienced these or other situations in staff and committee meetings, then you appreciate that staff and committee work is a complicated business. Within a management development laboratory attention is focused on the dynamics of decision-making groups and how to become a more effective member of a work group by joining a development group and studying its operations primarily through the use of feedback.



What Is a Development Group? Twenty-four participants form into two or three development groups of 8 or 12 men each, with the groups working together over the entire period. Even though participants hold different status positions in the refinery, there are no differences in the roles of people in the development group. The man with longest seniority, or who holds the highest position, or who has the most education, is not placed in charge.

The development group has neither a recording secretary, nor a president, nor does it have a parliamentarian. Furthermore, it has none of the ordinary work procedures for making decisions, such as voting, that are in the tradition of western culture. At the beginning, in other words, it has neither formal organization for discussion nor a procedure for identifying a discussion topic.

There is no agenda because no one has told members what to discuss. Since the group has neither a formal organization, nor an assigned topic, nor an established way of finding an appropriate one, it has to move to find out where it wants to go before it can get to where it wants to be.

The unique and fascinating feature of a development group experience is that none of the ordinary "benchmarks," or "yardsticks," or zero points which too often are witlessly used to evaluate work group performance are available. They simply don't apply. For example, you can't ask permission or lean on a decision if you don't have one. Furthermore, you can't get one to lean on unless you've agreed on voting or some other method as the basis for reaching agreement—and you can't agree on that if you've no basis for voting to see if it's the method you want to use!

The result is that each group has to start from scratch, so to speak, and step-by-step to design a system of government and law by which to regulate its

own conduct and through which to steer its own movement and effort. This means you have to examine decision points much more thoroughly than usually happens in work. It means every man has to search for direction, to become more sure-footed in order to substitute sound reasoning for the ordinary external "crutches" we have so thoughtlessly come to accept. It's a matter of gaining inner-direction to replace the outer directedness we've all come to depend on.

The Group at Work. What does the development group work on? Company policy? No. Company history? No. Economic trends? No. The brave new world? No, none of these. The *content* of discussion is not the important thing. It is *how* the discussion takes place that people study in order to perfect their skills of human interaction. The content may be anything such as whether or not to relocate the east gate of the refinery, how to improve relations between technical and practical people, why information tends to be screened and sifted as it passes from the bottom to the top of the organization or how "we are working together as a group, here-and-now."

Problems that are the topic of queries are ones such as, "Should we get a chairman?" "Is it necessary to raise your hand to show where you stand on an issue?" and "How are members exerting influence on one another?"

The real lessons come from exploring the questions concerned with, "How are we working together as a group?" It is from investigating this question that the fundamental training feedback which can produce change must come. An example of group level feedback of the kind which is so valuable from a learning point of view was presented in Part 2 of this series (PETROLEUM REFINER, June 1960, p. 227).

Here, however, we want to tackle only two aspects of development group operation. The two selected are typical of the more important kinds of problems into which development groups inevitably move. One is concerned with power relations and the other with criteria of agreement for when a decision has been reached.

Power Relations. The development group provides an unusually good vantage point from which to study power relations among individuals in a group. In the work of getting started, influence differences between individuals become apparent. Some quickly take the lead. Others fall into follower roles. But what is it that makes the difference; that determines the group "pecking order?"

There are several factors involved. One is the organizational rank or the position a person holds in the refinery. Do people that are higher in organizational rank, have more weight given their opinions by the others present? Another is whether a man is a technical man (college trained) or a practical man (i.e., refinery trained). Even with equivalent organizational rank, will

Relationship Between Organizational Rank and Individual Differences in Development Group Influence

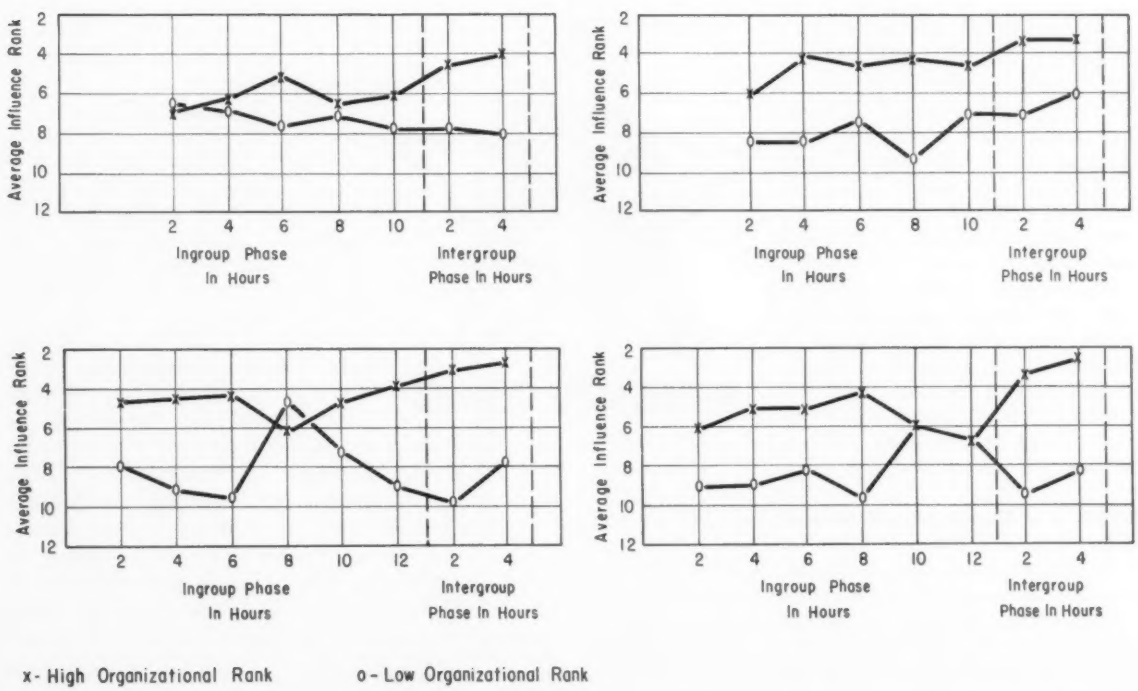


FIGURE 8—Higher organizational rank means more influence on group activities, particularly during intergroup phase.

Organizational Rank, Development Group Influence, and the Technical-Practical Distinction in an Industrial Setting

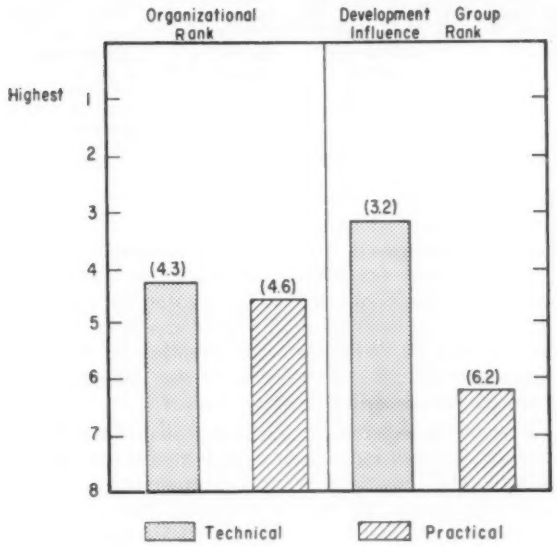


FIGURE 9—Technical and practical personnel in this situation have approximately the same organizational rank as shown on left. Technical personnel exert significantly greater influence on the activities of the development group as shown on right. (Measurements taken during the ingroup phase, prior to intergroup competition and based on the reactions of 34 technical and 30 practical personnel.

technical people exert more weight on the activities of the development group than practical people? Let's examine each of these in greater detail.

Organizational Rank. Take first the matter of the relationship between organizational rank and development group influence. Organizational rank is a simple mechanical index of a man's position in the refinery by his level in the hierarchy.

Is it true that the higher a man's level (i.e., manager, assistant manager, department head, division head, assistant division head, area supervisor, foreman, etc.) the higher is his influence level in the development group? When you stop to think about it, there is no particular reason that this should be so. People come into a development group to help one another learn, with the learning both personal and in terms of how a group operates. Yet Figure 8 shows that a group has a "subservience plan," which is based on the refinery.

The results from these four groups are typical of ones that have been obtained again and again. They indicate that, particularly when intergroup competition is introduced, the people of higher organization rank take over and run things. Figure 8 shows 30 different "check points" in four separate groups. In only two cases (in the first meeting shown in the upper left block and in the lower left block at 8 hours of meetings) are those of lower organizational rank higher in development group influence. There are two or three other instances when people of different organizational ranks have the same amount of influence, but in 25 of the 30 check point comparisons, Figure 8 clearly shows that higher ranking people are more influential in development group affairs than lower ranking people. Even though there should be no influence from organization rank in a learning situation such as a development group, the evidence clearly shows there is.

The shedding of attitudes of deference held by lower ranking people or "loosening up on the reins" by higher ranking people is not easy. Both sets of attitudes have been developed over the years. Though not shown in Figure 8, in the later meetings of development groups, the "spread" between higher and lower ranking people becomes less and less. Sometimes it even disappears altogether.

By examining data such as these during the course of a development group, higher ranking organization people get to see how they thoughtlessly add power to the opinions they express and lower ranking people have the possibility of experimenting with commending more attention for their own points of view.

Technical-Practical Distinction. After determing that organizational rank does influence individuals who compose the development group, we decided to ask a new question. Namely, "What would happen if groups were composed of the same organizational rank, but with an equal split of technical and practical people?" Under these conditions the subservience plan of the organization is eliminated, replaced by only the technical-practical distinction. Is the technical-practical disinction related to influence patterns within the development group?

The answer is "yes." The technical-practical distinction is related to development group influence. As you can see in Figure 9, with people of the same organizational rank composing the development groups, the technical people are the ones who exert the stronger influence on the group's operations. Why should it be so? Is it that technical people, having more education, have more to contribute to development group learning? Is it because educated people are more verbal? Or is it that they take the lead because it's forced on them by the practical people?

Even though the facts are clear, there is no good general answer to these questions. Therefore, only a suggested interpretation can be offered. A best guess is that the result is due to the verbal skill, not to ability differences, that the technical people use to contribute to learning. Being more verbal, technical people speak up quicker. At least in the beginning or early phase. They tend to listen to one another in order to compete with one another rather than to see themselves in competition with practical people whom they tend to ignore.

Being less surefooted at the verbal level, the practical man holds back and lets it happen until a pattern is set. All this is true in spite of the pretty widespread generalization that practical people have as great or greater knack in unraveling human reactions as technical peo-

TABLE 1—Procedures for Obtaining Agreement

Silence	Plop	Self-Authorized Decision	Handclasp	Topic Jumping	Clique or Sub-Group	Majority Minority Vote	Does Anyone Disagree	Thought and Feeling Consensus
No one does anything, an 0/0 situation	One person proposes but words fall on deaf ears	One person initiates action—others follow without agreement a 1/0 situation	Support of one member insures success of proposal	One or more people shift topic—no proposal is actually made	Minority support of decision	One more than half agree, the majority has the power of 1, the minority of 0	Opportunity provided for disagreement but no one speaks, a pseudo .5/.5 situation	Action taken only after "true" agreement by all is reached, a .5/.5 situation among group members

ple, and, therefore, their opinions on many matters should be given greater weight. Only when these patterns have been fully examined and explored in detail is the group ready to move on by reacting to each member in terms of ability or skill rather than in terms of rank difference.

When this happens you get a very different picture of things. You see people being more "open," disagreeing because they have genuine reservations rather than agreeing with something they really can't accept, in order to avoid "trouble."

The Group Decision. The second aspect of development group operation is concerned with the procedures used in a group for making a decision. Why is one procedure chosen over another? What are the implications for the involvement of members, the quality of decisions, and the readiness to take actions?

These are some pretty important questions in connection with making decisions, and all problem-solving groups must make decisions. Decisions may take many forms: rendering an opinion, making a specific recommendation, giving a solution for a concrete problem, defining alternative courses of action, handing down a verdict, or stating a general policy.

Two aspects are present in any decision-making. One is the *content*. Is it valid? Does it make sense? The other is *how* the decision is made. A decision made for a group frequently leads to unenthusiastic participation of those who must carry it out. Calling for a vote when the issue is hot and the group is split gives a bare majority decision. The result? Antagonisms and hostile feelings among those who have been defeated. Because of too little regard for the *how* side of making decisions, too frequently they have to be remade. Development groups do, and work groups should, study the procedures used in making decisions and how they affect the quality of decisions made.

The scale in Table 1 points to various degrees of agreement present among members when decisions are made. It is presented because these things are happening—all of them—in your refinery or office this minute. On the one extreme is silence, where there is no action because no one takes the initiative. At the other end is "thought and feeling consensus," where there is unanimity of opinion.

A way in which procedures vary is in the number of members who are in agreement on a decision. The number of persons giving support to a proposal may range from none, one or more in handclasp, to all or consensus. One basic rule is that the greater the expressed agreement, the more likely the decision will be successful in terms of "carry through." Another is, the more significant the decision the greater the importance of consensus as the criterion of agreement.

Procedures for assessing agreement may differ in the manner in which individuals express themselves. A yes-no show of hands has less carry through than a procedure where each "no" gets to express negative feelings, raise questions, and so on. The last way can result in greater commitment, for example, because personal reservations are considered with the possibility of resolving them prior to the time a person or the group is bound to act.

In Conclusion. In the development group, members have the opportunity to learn to recognize and to get muscle practice in supplying the functions necessary for effective decision-making. Steps in decisions-making can include such aspects as adequately clarifying the issues, maintaining a problem-solving atmosphere, testing ideas for feasibility and for consequences as well as actually assessing agreement or "making the decision." Adequate decision-making, whether in a development group or work group, depends, in large part, on the way decisions are made.

Once a group, committee or organization realizes these points, group action takes on new meaning. It's not just words. It's muscle. It's feeling. The development group experience is loaded with implications for better ways of utilizing groups for more productive work in a refinery. It is a most important basis for learning how to establish a system of work based on shared goals.

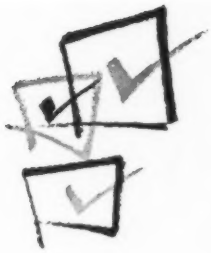
In "Applied Group Dynamics: Part 6" which will appear next month, you will read about these highly interesting and informative subjects.

1. Power relationships between groups.

2. The natural "superiority complex" of groups.

3. How group members react during intergroup competition.

4. Why strong groups antagonize each other—but ignore others.



Test Yourself on Labor Relations

No. 1. Testing Procedure

Jim Harvey put in a bid for a promotion to a higher-paid job. He felt sure he would make it because he was the senior man and had a pretty good record with the company.

Among other things, the new job called for the ability to "use gauges and measuring tools to produce quality work." Harvey was a little rusty on this phase, but felt he would pick it up quickly after his promotion. One morning, with no advance notice, he was called into the personnel office and asked to read a micrometer. He was unable to do so. A junior employe, Harry Baker was given the same test and passed it with flying colors. Baker got the job.

The company defended its action on the grounds that it tested the employe on a task that was vital to the job, and he failed. What other proof is needed that he isn't qualified?

"I was nervous," said Harvey. "This test was unfair. With a little practice I could learn to use the gadget. Teach me and give me a chance."

"We have a man who doesn't need any training. Baker can start right out at once, with no instruction. He gets the job."

Test Yourself:

Was the company: RIGHT ☐ WRONG ☐

No. 2. Seniority Policy

Alec Pough was a foreman for 5 years. He was promoted to that job after serving 4 years as an employe in the same department. Upon a reorganization, his department was combined with another, and Pough was put on layoff status. He put in a bid for a job. The company agreed and let out an employe to make room for Pough. The company's reason for doing this was that Pough had 9 years seniority — 4 as a worker and 5 as a supervisor. It based its claim on the following seniority policy:

"Computation of an employe's seniority will begin on the date the employe began work for the company and no deductions will be made for the time lost due to any reasons."

The union put in a vigorous protest:

1. Once a worker is promoted to foreman he loses his seniority. The contract covers employes — not management.
2. If Pough is to be rehired he should be put on as a new worker—at the bottom of the list.

The company argued:

1. Pough certainly had seniority when he was a production man. You can't take that away from him.
2. Under our policy, seniority cannot be "lost for any reason" so that his promotion to foreman meant that his seniority continued to accumulate.

Test Yourself:

Was the company: RIGHT ☐ WRONG ☐

Answers on Page 365

How to Do It...

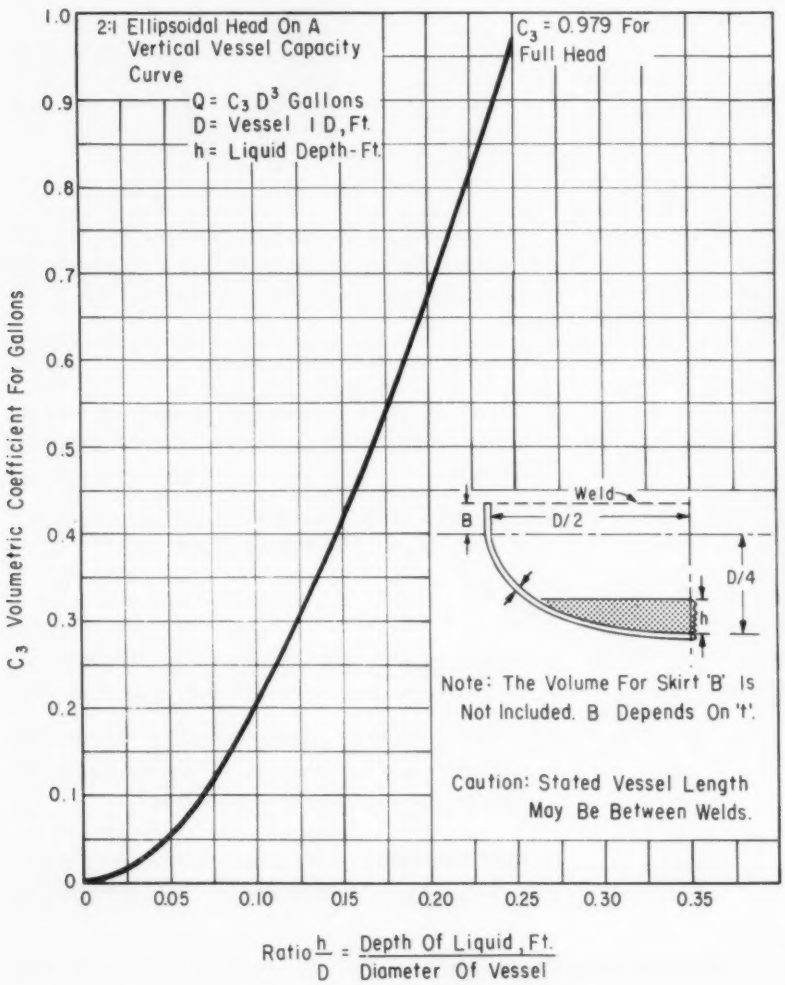
Use Chart to Find Capacity Of 2:1 Ellipsoidal Head

When using vertical vessels with 2:1 ellipsoidal heads, you sometimes need to know how much liquid (by volume) is in the head at various depths. Here is a convenient chart that will allow you to find the volume quickly and easily.

The chart was plotted by computing a series of coordinates from the ellipse formula. These were then used to compute the volume of incremental spherical segments of two bases. The cumulative volume for the full head by this method checked the volume determined by the ellipsoidal formula.

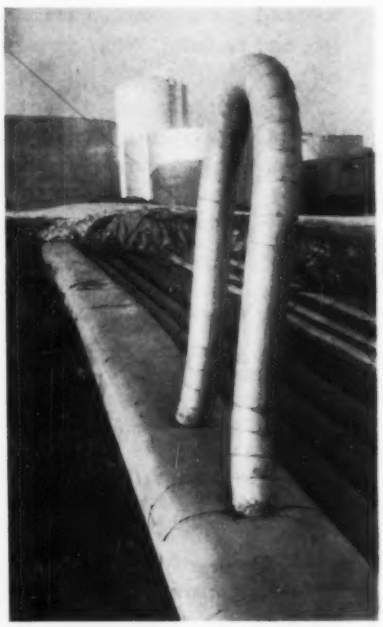
To find the volume of the head, divide the depth of the liquid in the head, in feet, by the diameter of the vessel ID, in feet. Using this ratio, enter the chart and at the intersection of the plotted line read the volumetric coefficient for gallons, C_3. Multiply the vessel's ID in feet by C_3 to find the volume in gallons.

Item submitted by H. C. Severin, California Research Corp., Richmond, Calif.



Steam Traced Bunker Oil Lines Need Expansion Loop

A neat arrangement for keeping heavy bunker oil loading lines to barge terminals hot, so that the product will flow, is to wrap them in insulation with a steam line in between. The bunker oil lines do not get hot enough to cause too much trouble with expansion, but the steam line in the middle will disrupt the entire assembly if room is not made for expansion. One company places a loop in the seam line ever 300 feet so that it can expand and contract. The loop is carefully insulated and the ends wrapped with the oil line as shown. When it is time to heat a tank to be shipped, the steam is placed in the heating line and the product is kept hot until it reaches the barge.



More light on producing hydrogen economically ...Tidewater uses heat-resistant Incoloy tubing

Tidewater Oil Company's new Delaware refinery requires huge amounts of hydrogen for desulfurizing. They obtain it by reforming propane.

High temperature-pressure problem

Metal temperatures in the reformer furnaces are in excess of 1700°F with internal pressures of the reacting gases sufficiently high to emphasize the need for strength and ductility. To provide these properties, the tubes in one furnace are made of extruded Incoloy* nickel-iron-chromium alloy.

Incoloy is the solution

Incoloy alloy exhibits high creep strength and rupture strength combined with satisfactory ductility. It is not susceptible to embrittlement resulting from structural changes after prolonged heating. Of special importance in containing hydrogen under pressure is the ability of the alloy to provide welds of high integrity. Furthermore, when used in the extruded form, the alloy offers decided economies over other materials.

Incoloy alloy is also used here in the reformer heater outlet manifold and reformer outlet to desuperheater.

For more information you are invited to write for a free copy of *Properties of Incoloy*.

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How To Do It . . .

Nomograph Gives Net Price After Vendor's Discounts

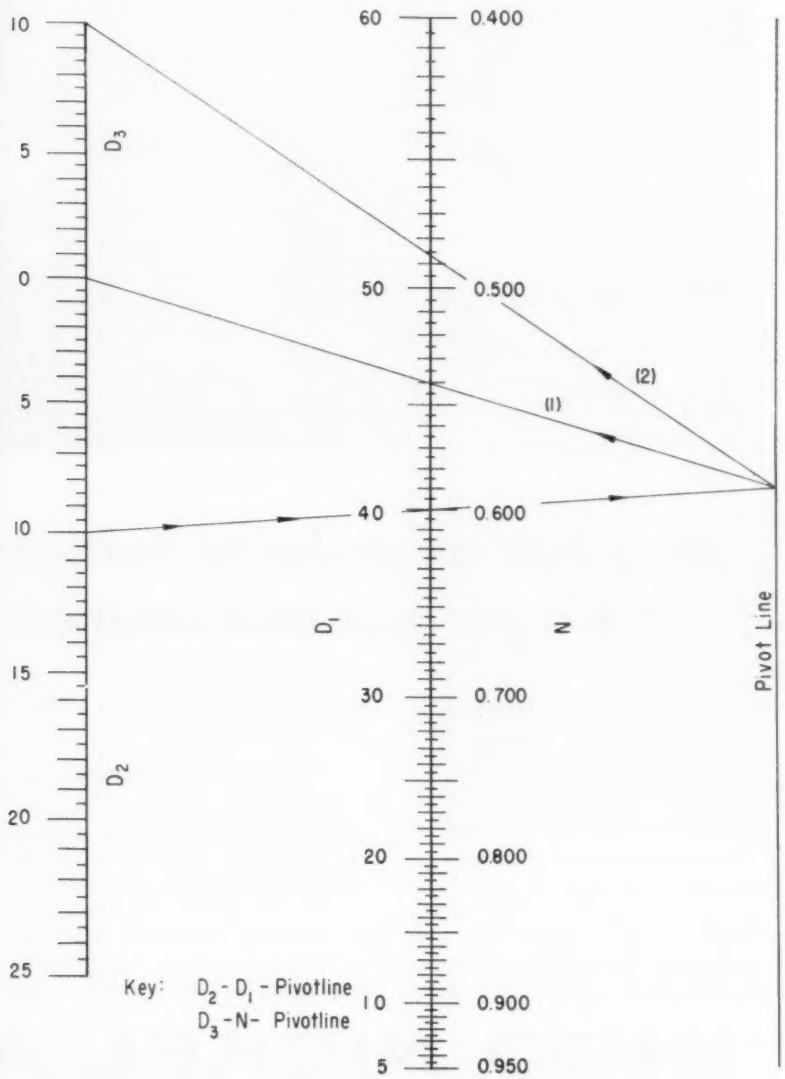
Vendors frequently quote the cost of an item as a list price minus one or more discounts. The monograph graphically solves the following equation:

$$N = \$1.00 \times \left(1 - \frac{D_1}{100}\right)\left(1 - \frac{D_2}{100}\right)\left(1 - \frac{D_3}{100}\right)$$

Example 1: An item sells for \$1,000 list price minus 40 percent minus 10 percent. What is the net cost? Align $D_1 = 40$ with $D_2 = 10$ and continue to the pivot line. Align the point on the pivot line with $D_3 = 0$ and read $N = 0.540$. Therefore, the net cost is (1,000) (.540) equals \$540.

Example 2: Same as above except there is an additional 10 percent discount. Align the pivot line $D^3 = 10$ percent and read $N = 0.486$, or the net cost is \$486.

Item submitted by F. Caplan, Kaiser Engineers, Oakland, Calif.



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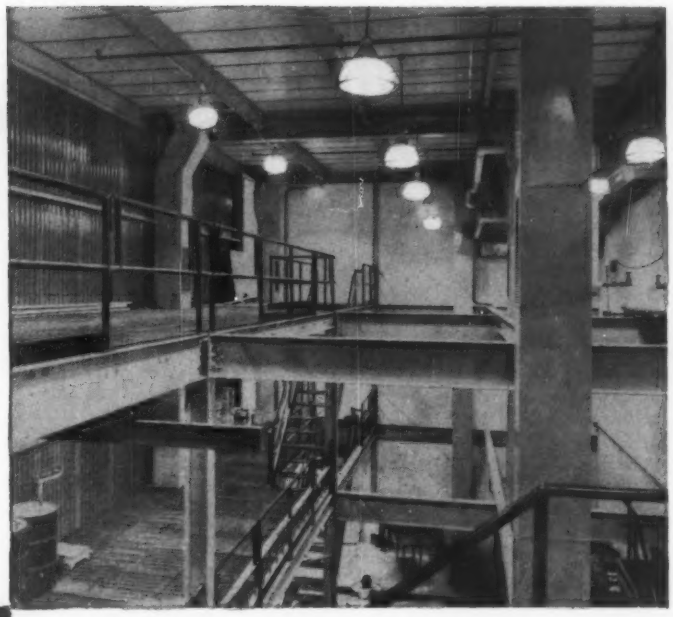

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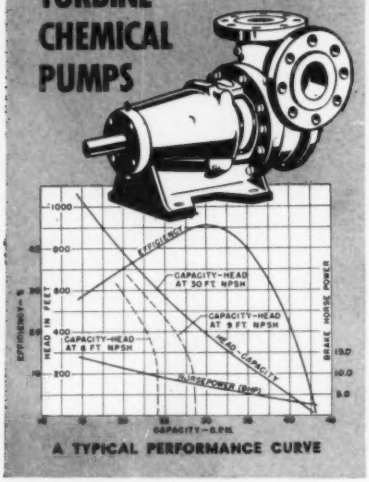

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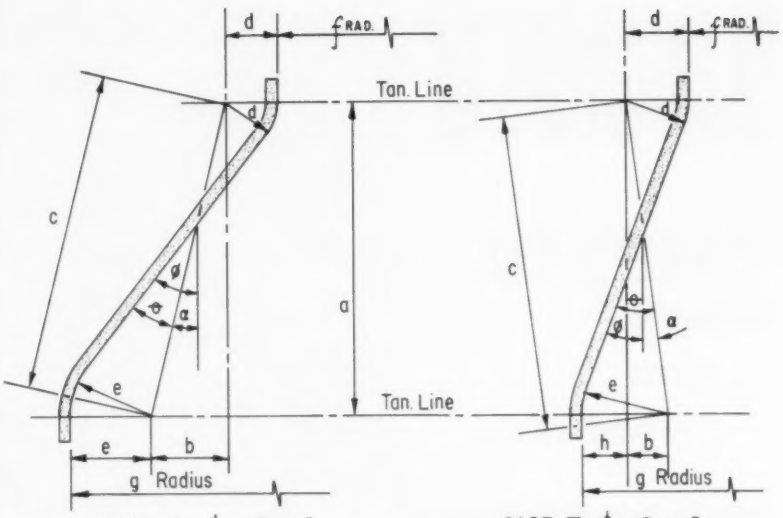

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θ = _____ °
Sum = _____ = ϕ

g = _____
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θ = _____
α = _____
DIFF = _____ = ϕ

Find the Cone Angle in Heads with Knuckle Radii

The ASME Boiler and Pressure Vessel Code, Section VIII, paragraph UG 32 (h) specifies that Toriconical heads shall be used in place of straight cones with no knuckle radius when the angle exceeds 30°. It is a simple matter to compute the angle of a straight cone which has no kunckle radius, however, when knuckle radii are added at each end of a transition piece, the problem of determining the exact angle is made a little more difficult. The work sheet shown here for determining the angle of the cone with knuckle radii will simplify computations and will also speed up these computations since the formulas are put down in standard form.

Case 1 will be used when g minus e is greater than f plus d.

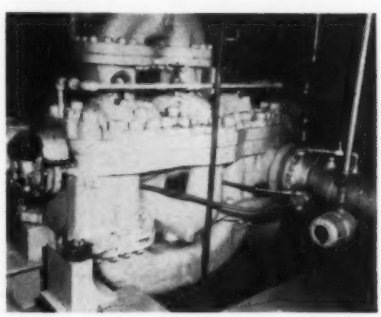
Case 2 will be used when g minus e is less than f plus d.

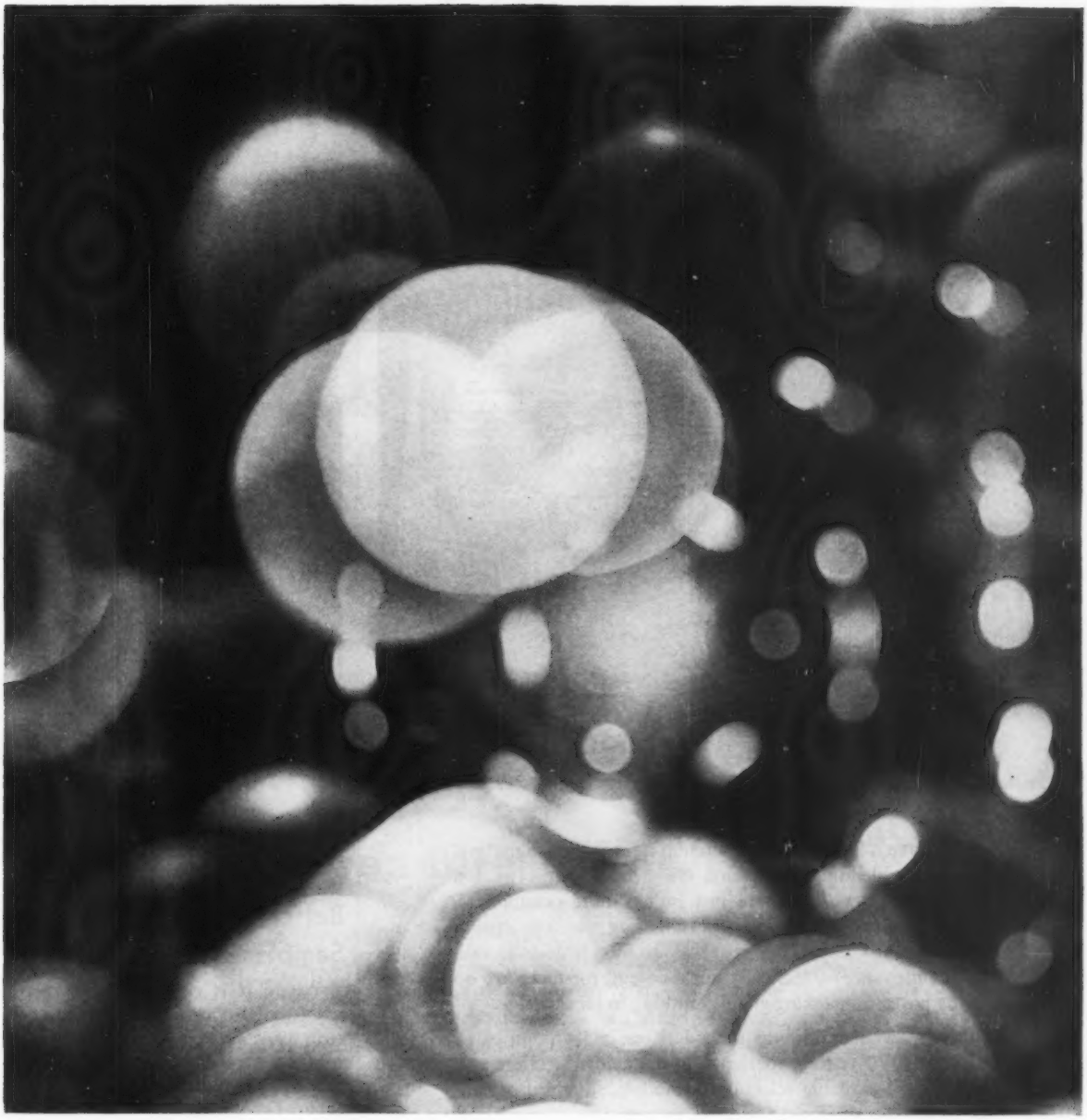
To find the required angle, simply fill in the blanks on the work sheet.

Idea submitted by Royce Baker, Fritz W. Glitsch & Sons, Inc., Dallas Texas.

Float Switch Stops Engine When Packing Gland Leaks

A simple way to keep packing gland leaks from becoming a hazard on remote controlled pumping units is to connect the drain line from the glands into a central float chamber and connect the float to a switch which will





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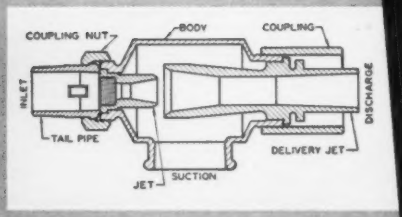

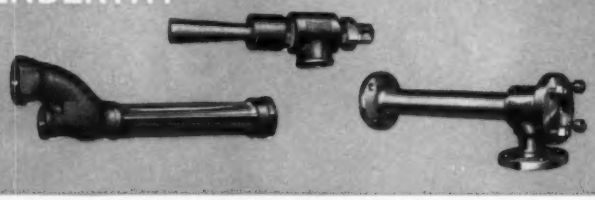

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How To Do It . . .

ground out the engine in case the pot fills up.

The bottom of the pot has an outlet where the valve can be pinched if it is desired to allow slight leaks in the packing for lubricating purposes. Whenever the leak becomes excessive, it will raise the float and the switch grounds the low-tension circuit on the magneto of the pumping engine or cuts off the switch on an electric motor if that is the prime mover.

Better Way To Get Tank Samples From Three Levels

Where it is necessary to keep a strict and frequent check on the contents of a tank, a sampler with connections to the top, middle and bottom of the tank will save operator time when collecting the samples. The fluid is run through half-inch pipes to a sump chamber with an outlet leading to the slop tank. At prescribed intervals, the operator bleeds the contents of each line into the sump chamber then takes a sample to be analyzed. This prevents the trouble and slop and uncertainty in thieving the tank in order to see what is at each level.

Tank Sampler Made From Scrap, Bottle And Cork

Where it is necessary to take samples from various levels in a tank, a homemade thief can be rigged up

RING OF STEEL

Defies Pressure Times Ten

The Flexitallic gasket in the bonnet joint of Hancock Steel Gate Valves cannot blow out even if pressures exceed ten times the rating of the valve. Valve maintenance and equipment down-time are greatly reduced. Made of a spiral-wound ribbon of stainless steel with asbestos filler, the gasket has spring-like compressibility — cannot be flattened.

Only the specially-designed Hancock bonnet joint with built-in compression limit can make full use of the positive sealing power of this ring of steel. Such advanced valve engineering is one example of total Hancock quality that assures trouble-free performance. Your nearby industrial supply distributor will gladly explain every economy feature of Hancock Steel Gate Valves. Phone him today.

Hancock 800# Steel Gate Valve, Type 950. Sizes: ¼" thru 2".

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Watertown, Massachusetts

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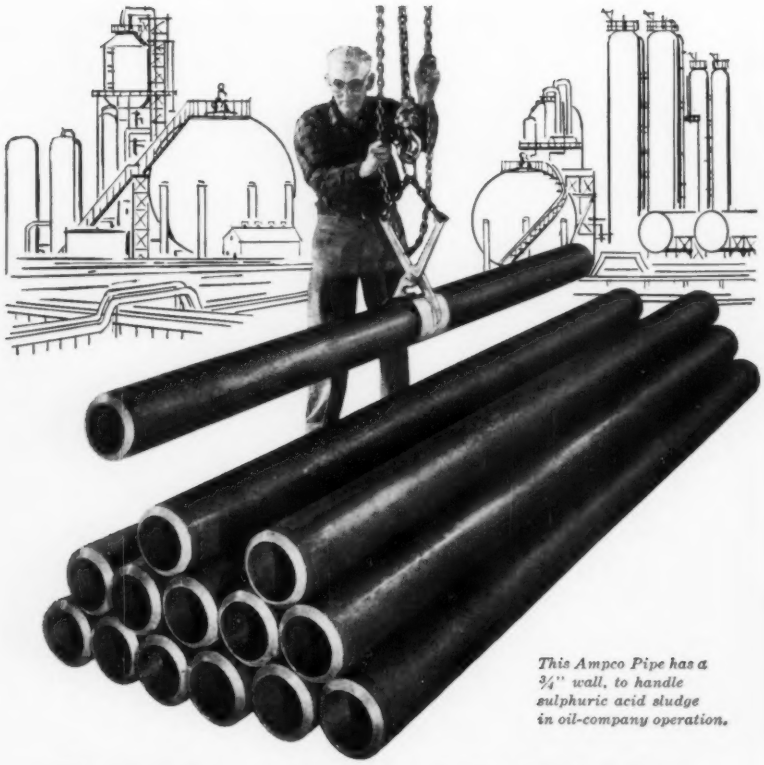

This Ampco Pipe has a ¾" wall, to handle sulphuric acid sludge in oil-company operation.

Sulphuric Acid Sludge No Problem

for major oil company,* in 1000-lb. transfer service

Its Ampco Pipe and Fittings resist corrosion

Ampco Pipe successfully handles problem liquids like these:

Boiling sulphuric acid (up to 50%)

Hot concentrated caustic solutions

Phosphoric and acetic acids

Phthalic anhydride

Phenols

Furfural

Brine

*Name upon request

Many other companies avoid corrosion shutdowns this same way.

Ampco Pipe is made from an exclusive aluminum-bronze alloy that . . .

(a) Resists many acids and caustics.

(b) Withstands the action of abrasive solids in suspension—resists cavitation-pitting.

(c) Has a Brinell hardness of 150 and tensiles up to 70,000 psi.

(d) Stands up under wrenches and hammers, without thread distortion and subsequent leakage.

(e) Has high velocity tolerance — flow rates of 18-20 fps.

You can get Ampco Pipe in all standard sizes, many from stock. Fittings are available to 3000 psi; flanges, to 5000 psi.

Write us concerning *your* problem.

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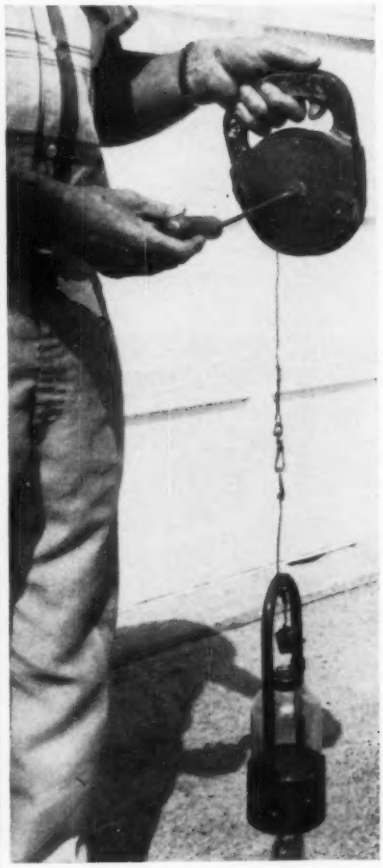
How To Do It . . .



with a cork and bottle and a few pieces of scrap metal.

The reel is made up from a sheave with a crank and handle and the bottle sets in a compartment which allows it to slide two ar three inches. The sample is obtained by inserting the cork tightly and lowering it to the level where the sample is desired. The weight of the bottle hangs on the cork and when the line is given a jerk, the weight of the bottle, plus the friction in the liquid easily pulls the cork loose and the tank can be sampled within an inch of the desired depth.

The band of metal which holds the bottle in an upright position slides on the bail of the container so that the bottle is held upright at all times. When the bottle is removed from the tank, the band can easily be lifted off the end and the bottle removed.

For more data on advertised products, use Readers' Service Cards, last page.

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Now . . . by an exclusive process just developed . . . we're producing a new, high-quality oxide that consistently assays *above* 96%.

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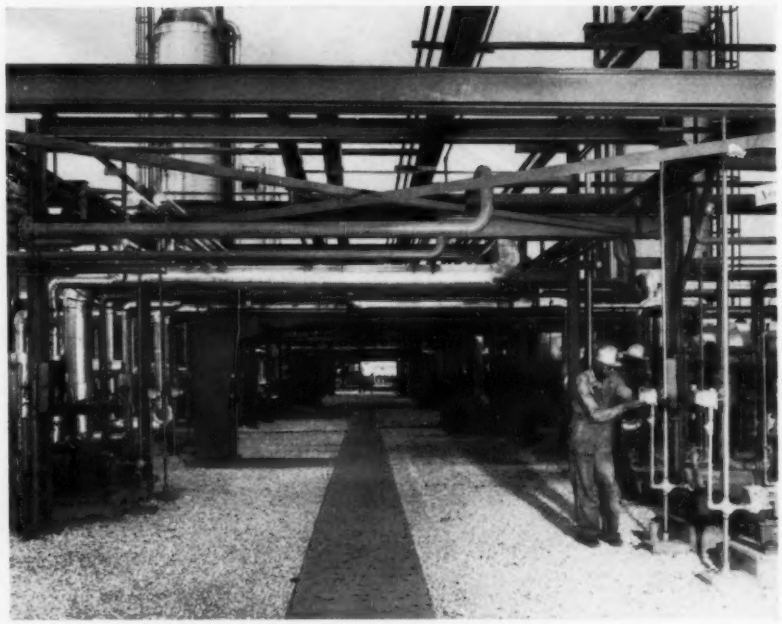
Who's Building...

Rayne Field Gas Plant Begins Operations With 176 MMcfd Capacity

La Gloria Oil Unit costs $3,855,000



Operator starts the plant's stabilizer reflux accumulator.

The Rayne field gas processing plant of La Gloria Oil and Gas Co. began operation recently with the capacity for delivering 176 MMcfd of residue gas to the transmission facilities of Texas Eastern Transmission Corp. Design recovery efficiencies at a residue gas volume of 155 MMcfd are 75 percent propane, 95 percent for butanes, and 100 percent for heavier hydrocarbons. Construction costs amounted to about $3,855,000 with the work being done by Brown and Root, Inc.

Gas and liquids are received from the 21 individual well separators at 2,900 psig. The gas from these separators is sent to four low-temperature separators; liquids recovered here, along with liquids from the individual well separators, are fed to a 1,250 psig flash tank. Its flash gas combines with the main gas stream from the low-temperature separators to feed the absorbers, while the liquid is flashed twice more at 525 and 210 psig and then fed to a 185 psig stabilizing tower. The stabilizer liquid, with a vapor pressure of 5.5 to 6.0 pounds, is sent to storage for delivery to two pipeline connections.

The gas stream to the absorbers is cooled by heat exchange with the residue gas and then chilled to 40° F with a propane chiller. To prevent the formation of hydrates, diethylene glycol is injected into the gas stream ahead of the chiller. A scrubber downstream from the chiller removes the rich glycol from the gas stream before it enters the absorbers.

Residue gas from the absorbers, which operate at 1,235 psig, is used to presaturate the lean oil stream. After mixing, the lean oil-residue gas stream is chilled in a propane chiller to 40° F and separated in a presaturator tank. The cold, presaturated lean oil is pumped from the presaturator tank over the absorbers.

From a 210 psig rich oil flash tank, the rich oil steam is heated by exchange with the hot lean oil en route from the still to the main lean oil pumps, and fed to the demethanizing tower at 150° F and 165 psig. Rich oil from the bottom of the demethanizer is pumped through an additional rich oil-lean oil exchanger into a hot rich oil flash tank operating at 355° F and 175 psig. Vapors from this flash are returned to the demethanizer to serve as stripping gas. The upper section of the demethanizer is a reabsorbing column. A side stream of lean oil is drawn off the second stage of the main lean oil pumps, chilled to 40° F in a propane chiller, and used to contact the vapors stripped from the rich oil in the lower or demethanizing section. The rich oil is removed from the bottom tray of the reabsorbing section and pumped into the rich oil stream en route to the demethanizer from the 210 psig rich oil flash tank.

The hot rich oil leaves the hot rich oil tank, is further heated through rich oil-lean oil heat exchange, and fed to the still at 480° F and 95 psig. Lean oil from the still at 590° F is returned through the series of rich oil-lean oil exchangers, and a water-

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The gold Flexite Finish* for the metal gauge rings in Flexitallic Compression-Gauge Gaskets is new. It is highly corrosion resistant when exposed to severest weathering in open construction projects or in stock. The Flexite Finish provides for ease of identification and a clean, long-lived installation. Write for samples.

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cooled lean oil cooler, to the main lean oil pumps at 95° F. The main lean oil pumps then return the lean oil to the presaturation equipment. In stripping the absorption oil in the still no outside stripping steam or stripping gas is used. Heat is supplied at both the still bottom and the fourth tray below the feed tray. Oil is removed at each point, pumped through direct fired heaters, and returned to the point of withdrawal at 595° F.

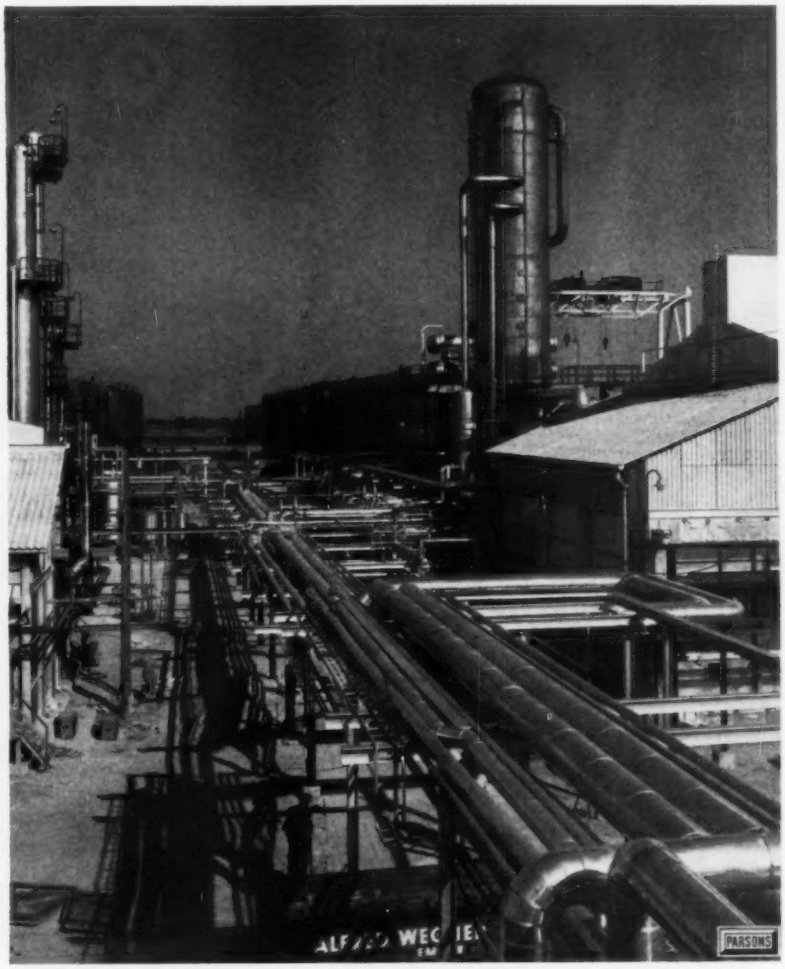
The still overhead product at 220° F passes through the still reflux condenser, a flooded still reflux accumulator where reflux is withdrawn at 110° F, and a product cooler where it is further cooled and condensed at 95° F and sent to the still product accumulator at 80 psig. From this accumulator the liquid is pumped, and the uncondensed vapors compressed, to a pressure of 175 psig. The two phases are recombined at this pressure, condensed at a temperature of 100° F, and sent to the raw make tank. Both temperature and pressure are controlled on the raw make at the above figures.

The raw make is then pumped to the de-ethanizing column operated at 465 psig with a bottom temperature of 220° F and a top temperature of 70° F. Reflux is condensed in a propane chiller with the overhead product going to the plant fuel system. The bottom de-ethanized product, with a vapor pressure of 120 psig at 100° F, is sent directly to two pipeline connections where it is metered as delivered. Feed to the de-ethanizer is heated by heat exchange with the bottom product.

The overhead gas from the stabilizer referred to earlier is fed into the bottom section of the demethanizer. A portion of the overhead gas from the demethanizer reabsorber column is used to make up the additional plant fuel not obtained from the de-ethanizer. The remainder, along with the 210 psi rich oil flash gas and the 210 psi separator liquid flash gas, is compressed at 525 psig. Here the 525 psig rich oil flash gas and the 525 psig separator liquid flash gas are added to the stream and a second stage of compression to 1,250 psig returns the combined streams to the absorber feed gas stream ahead of the feed gas-residue gas exchanger.

The plant is designed to recover 28 barrels of a de-ethanized propane, butane, condensate mix and 58 barrels of 5.5 to 6.0 psi vapor pressure separator liquid, per MMcfd of residue gas.

An alarm system to warn the operator of upsets in operating conditions is both audible and visible. For this purpose the plant is divided into three areas; processing with a horn signal, engine with a whistle, and heater with a siren. Lights on the control panel in each area indicate the source of the alarm. In addition the engine rooms have a companion light above the building which indicates which building contains the trouble spot. Alarms are actuated by high levels in the compressor suction scrubbers, fuel gas scrubber, and residue gas scrubber; low level in the still; hydraulic turbine overspeed; pump stoppage on presaturator, still reboil, cooling tower, and main lean oil pumps; freezing of the lean oil-residue gas chiller; stoppages of compressor, generator, main lean oil pump, and instrument air compressor engines or motors; high flow in heater tubes; and high-stack temperature on heaters.



30,000-bpd refinery will produce premium and regular gasoline, LPG, diesel fuel and fuel oil of varying grades.

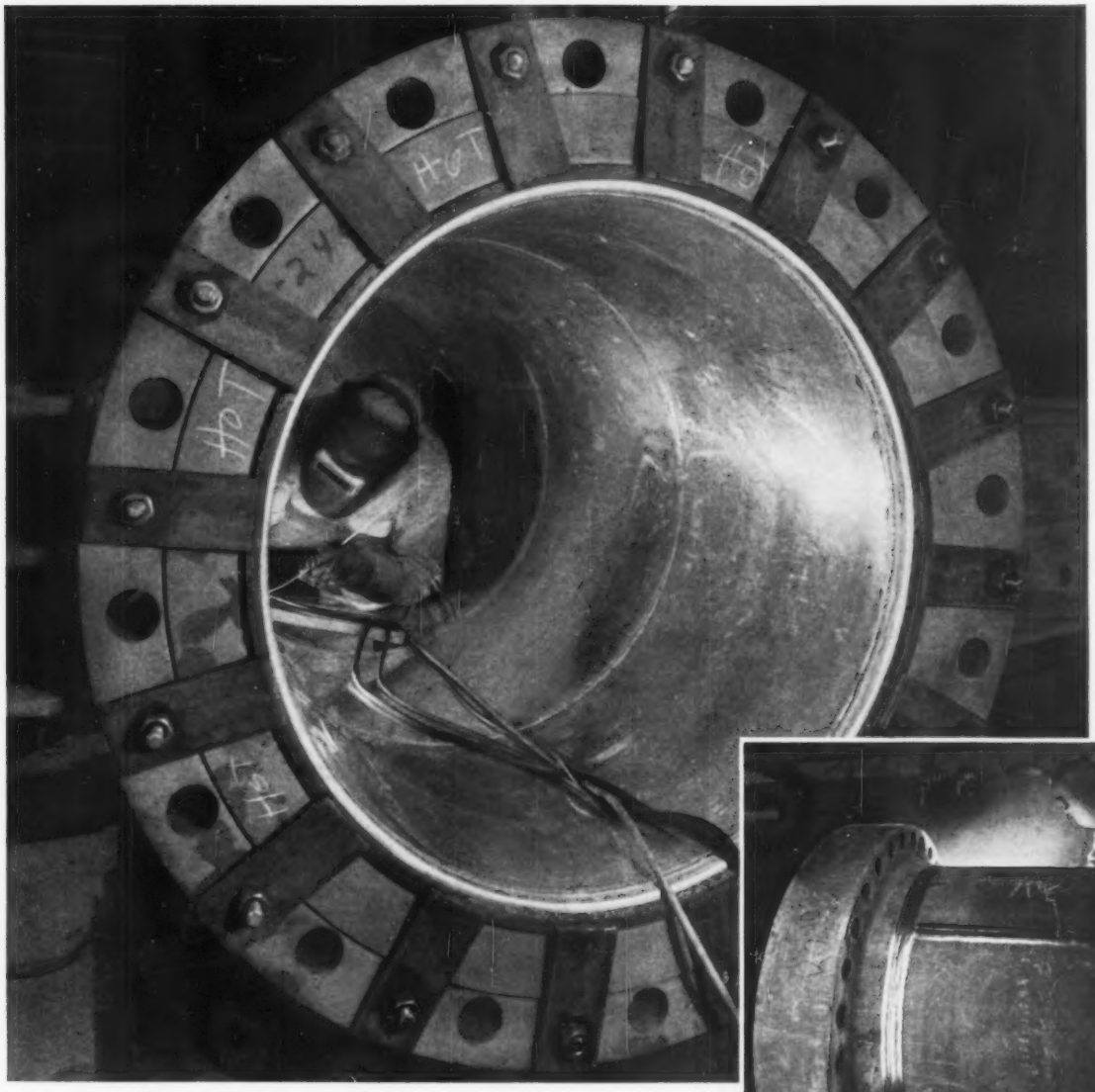
Frisia Plant on Stream Well Ahead of Schedule

The Frisia Erdoelwerke A. G. 30,000-bpd refinery at Emden, went on stream last month, several months earlier than originally scheduled. Products will be premium and regular gasoline, LPG, diesel fuel, and fuel oil of varying grades.

Principal units of the refinery include crude distillation, distillate desulfurizer, naphtha desulfurizer and reformer, steam and utility plant, crude and product tankage, barge and ship loading wharves, and tank car and truck loading racks. Process design, engineering, procurement, construction, and start-up of the grass-roots job was performed by The Ralph M. Parsons Co., engineers-constructors, Los Angeles.

Texaco, Inc.'s cumene unit at its Eagle Point plant, Westville, N. J., has been placed on stream with a 70-million-pound capacity per year.

The Dow Chemical Co. has a polyglycol expansion under way at its Freeport, Texas, plant. Production is expected to begin in early 1961.



GAS PURIFIER . . . WITH A SILVER LINING

The Nooter welder pictured here is lining a high pressure reactor with a 1/16" thick pure silver sleeve. This is one of two identical units that include silver lined agitation shafts and connecting pipes.

In addition to a regular flow of steel vessels through the Nooter shops, the Nooter Alloy Department is constantly fabricating and developing new welding techniques involving all weldable materials, including stainless, nickel, aluminum, their alloys and clads, and silver, gold, Hastelloy, titanium, tantalum, zirconium and zircaloy-2.

Nooter customers benefit from the skill and experience of metal craftsmen who specialize in tough fabrication assignments. Whatever your tank or processing vessel needs, Nooter can produce it to your complete satisfaction. Why not put this ability to work for you?

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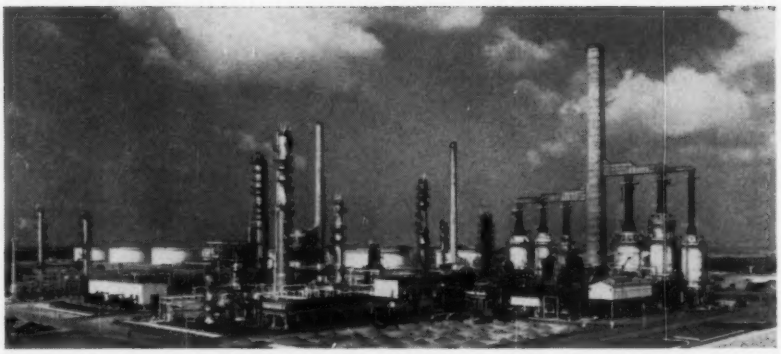
Building . . .

British American Oil Co., Ltd., is planning construction of a $2.5-million aromatics extraction plant at its Montreal East refinery. Building will begin this fall on the unit which is scheduled to go into operation before July 1, 1961. It will be a Udex aromatics facility developed jointly by Universal Oil Products Co. and The Dow Chemical Co. A prime product of the extraction plant will be benzene, which is required for the cumene operation at the nearby British American Shawinigan petrochemical plant.



Rotterdam Refinery on Stream.

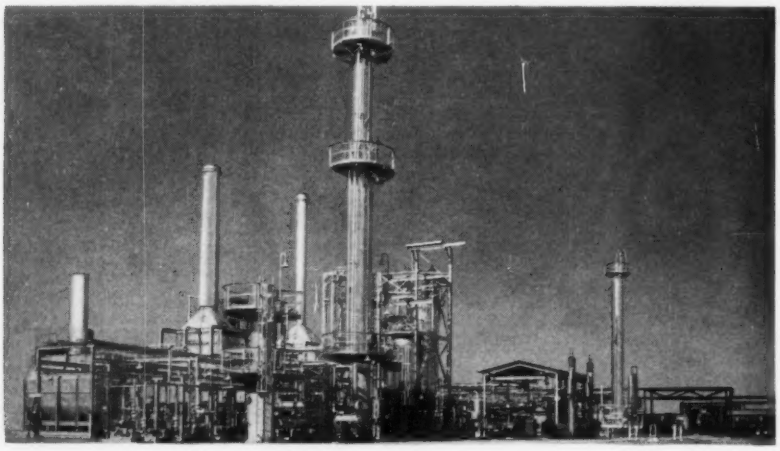
Esso Nederland Completes $50-Million Rotterdam Unit

Esso Nederland's $50-million, 100,000-bpd Rotterdam refinery is now on stream. Badger N. V., Dutch affiliate of Badger manufacturing Co. handled construction. With an annual capacity of close to 5 million tons, the refinery will supply Esso's requirement for the Dutch market for refined products with the balance of the production slated for export. The new facilities are located on the Third Petroleum Harbor, part of the Maas waterways system in the Rotterdam area. Actual construction of the project was completed in only 24 months.

Catalytic reforming is accomplished with Esso's Powerforming process. This unit is designed to stay in production continuously with catalyst regeneration being accomplished while the equipment is on stream. Other units include crude distillation, naphtha stabilizer, Hydrofiner, copper chloride treater as well as steam generation, water supply, electronically-controlled loading system, tankage and other ancillary facilities.

Signal Oil Co. has begun a multi-million-dollar expansion and modernization program at its Houston Division's refining and petrochemical complex. Additions include a catalytic cracking tower and a Hydeal unit for converting toluene into benzene. The Hydeal unit is a processing system developed by Universal Oil Products Corp. and Ashland Oil and Refining Co., and will produce about 1,000 bpd of benzene. The facility is expected to go on stream in late December or early January. The cat cracker, with a 15,000-bpd feed capacity, is being brought to the Houston site from Destrehan, La. Procon, Inc., will build the Hydeal unit. Brown & Root Construction Co., has the contract for moving and reconstruction of the cat cracker.

American Rubber and Chemical Co. is planning a multi-million-dollar plant at Louisville, Ky., to produce poly-



PERFORMANCE PAYS OFF FOR SIGNAL

The Catalytic Reformer at Signal Oil and Gas Company's Bakersfield Refinery was on-stream and making specification product 24 hours after naphtha was first cut in. Today, 8 months after the initial startup, the unit is still on its uninterrupted first run. The C. W. Nofsinger Company played a key role in the design of this unit by providing the following: PROCESS DESIGN, MECHANICAL FLOW DIAGRAM, PLOT PLAN AND EQUIPMENT LAYOUT, SPECIFICATIONS FOR COMPETITIVE BIDS, EVALUATION OF CONSTRUCTION BIDS, REVIEW AND APPROVAL OF DETAILED ENGINEERING DRAWINGS.

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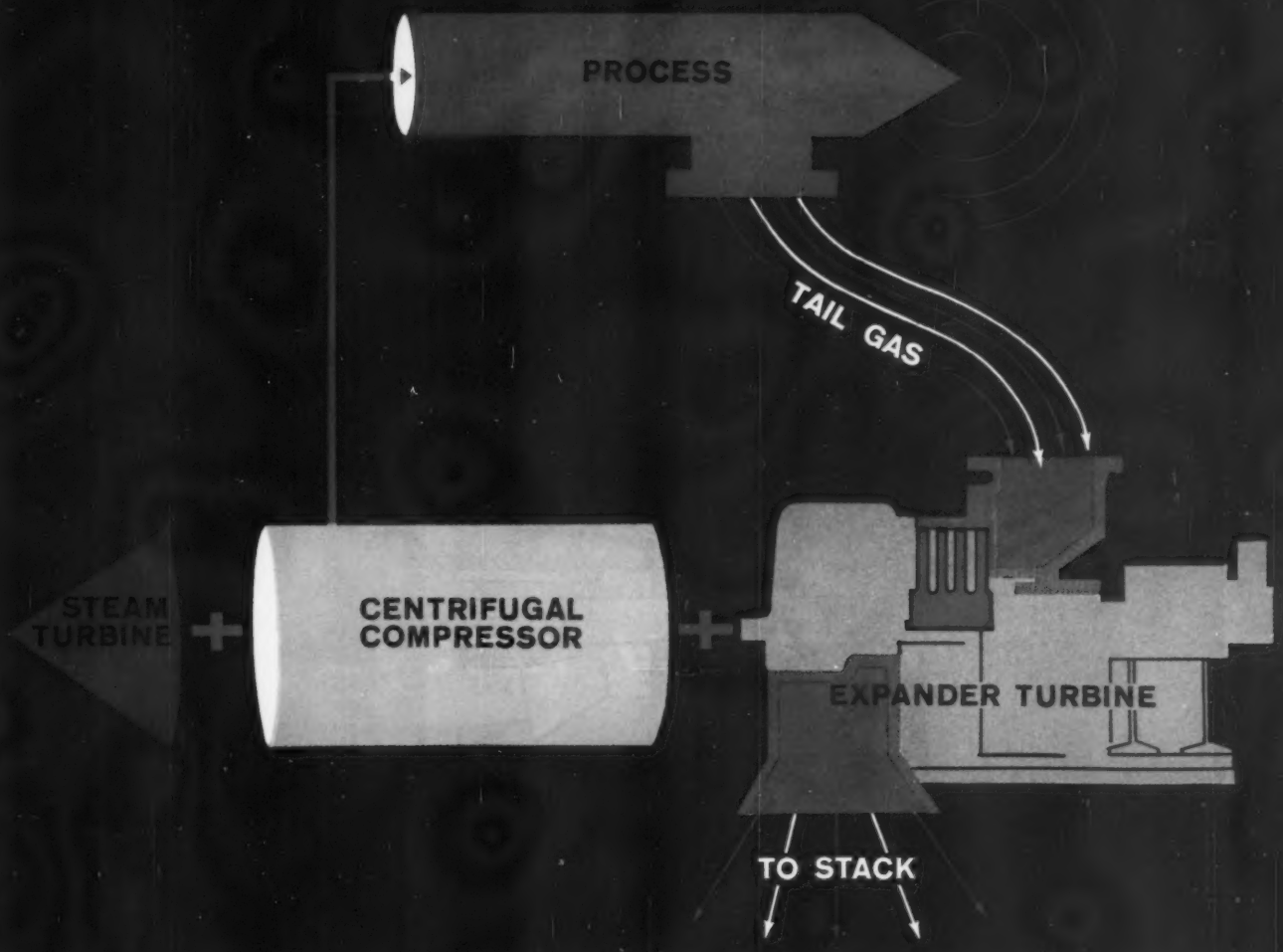

TAIL GAS WAGS PROCESS, SAVES ⅔'s POWER COSTS

In less serious moments we call it "tail-wagging." Actually, it's the art of taking substantial amounts of power from process exhaust or "tail" gases. By making the tail wag the dog . . . putting this power back into the process . . . major increases in efficiency can be obtained.

The key machine is the turbine gas expander that returns power to the process by serving as a prime mover. In one process, for example, a centrifugal compressor delivers air to the process. After reaction, in which the oxygen is removed, the residue or "tail" gas leaves the process at extremely high temperatures and under pressure. Passed through a turbine expander, this gas does useful work.

This work can be applied to driving generators, blowers or geared to reciprocating equipment. If used driving a centrifugal compressor, it can supply as high as 85% of the driving power. An auxiliary motor or steam turbine can provide the make-up and start-up power.

Recent developments in design, materials and manufacture have now made "tail-wagging" with high horsepower, high temperature turbine gas expanders possible for a variety of processes. At Worthington we have answers you need to make a complete study of this new opportunity for process plant economy. For information about "tail-wagging" (turbine gas expanders and their application) please write Worthington Corporation, Expander Section (48-10), Wellsville, New York.

WORTHINGTON

Building . . .

butadiene and polyisoprene synthetic rubbers. The company has obtained a license for the processes to be used from Phillips Petroleum Co. Construction of the production facility has already begun with completion scheduled for September, 1961. American Rubber and Chemical Co. is a joint venture by Stauffer Chemical Co., New York, and American Synthetic Rubber Co., Louisville. The new unit will be located adjacent to the present American Synthetic Rubber plant. Initial capacity will be 15,000 bpd of crude charge annually.

Standard Oil Co. (Indiana) is building a 12,000-bpd alkylation plant at its Whiting refinery. Bechtel Corp. has received the construction contract for the unit, which is set for completion in early 1961. The new unit will combine and upgrade certain components of liquefied refinery gases into a high-grade gasoline stock required for high-compression engines. The plant will have three 120-foot-long reactors and a 150-foot-high fractionating tower.

The Firestone Tire and Rubber Co.'s Firestone Plastics Co. Division has awarded Catalytic Construction Co. a contract for engineering, procurement and construction assistance of the expansion of a polyvinyl chloride resins plant at Pottstown, Pa. The facilities are expected to be completed and in operation by early 1961.

Celulosa y Derivados, S.A., plans to build plants for the production of hydrofluoric acid, carbon tetrachloride, and fluorinated hydrocarbons, at Monterrey, Mexico. General Chemical Division, Allied Chemical Corp., will provide technical information for the project. The plants are expected to be completed in the first part of 1961. None of the chemicals is currently produced in Mexico except for hydrofluoric acid which is made in limited quantities.

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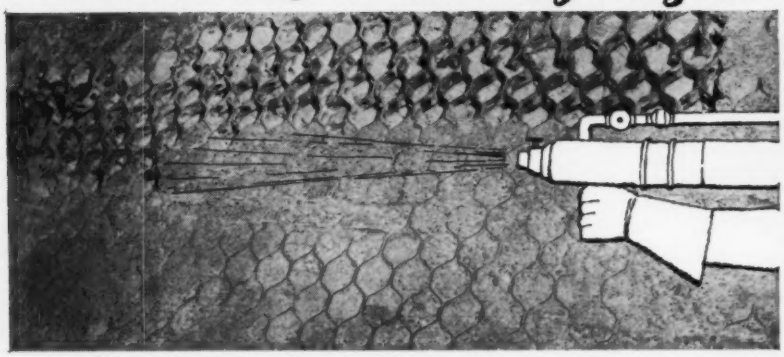

Perfect balancing and blending—a marked uniformity of grain structure for absolute homogeneity is just one of the extras in Walsh Refractory Castables for the refining industry. Together with superior bonding qualities, maximum resistance to abrasion, excellent compaction, low rebound loss and high modulus of rupture, you get all the wanted characteristics that result in more efficient service throughout a longer life. There is a light weight insulating, high temperature service type, or iron and sulphur-free castable with suitable "K" factor to meet every refinery need—whether for airgunning, pouring, or trowelling—that will do your job better at less cost.

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SUPER CASTABLE NO. 32—(Iron-free
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LITE-WATE No. 70, for one-shot lining, 70 lbs./cu. ft.
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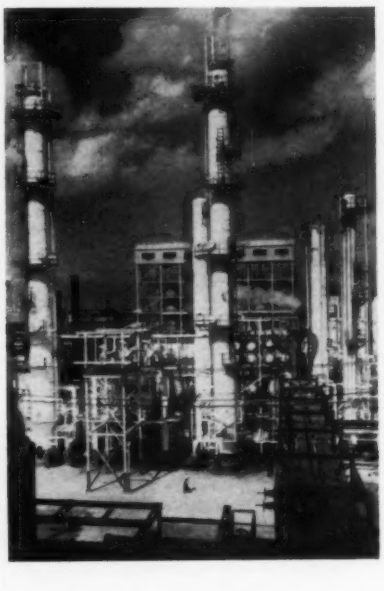
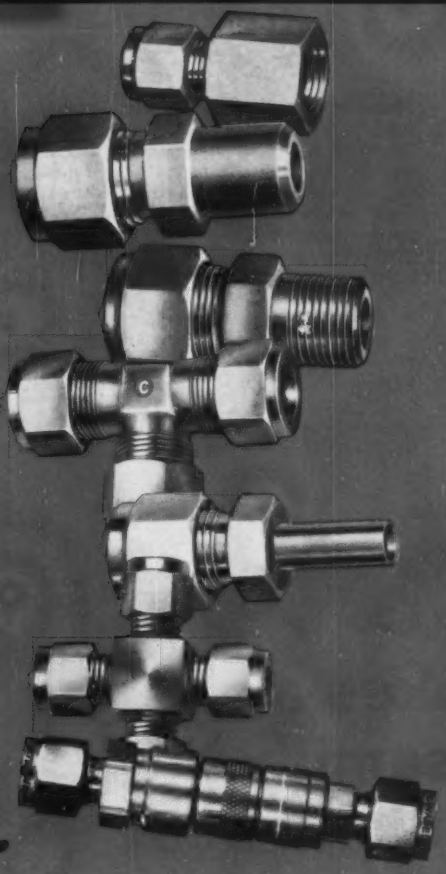


Fractionating Towers Built At Gulf's Port Arthur Plant

Several new propylene polymer fractionating towers have been completed by Gulf Oil Corp. at its Port Arthur, Texas, refinery. One of the products from the facility will be used in the manufacture of another petrochemical, Decyl Alcohol, by the company. The remaining products are sold by Gulf for conversion primarily to detergents.

El Paso Natural Gas Co. and Rexall Chemical Co. have awarded three multi-million-dollar contracts for construction of petrochemical plants at Odessa, Texas. Fluor Corp., Ltd., will build a chemical plant which will be operated by Rexall. Universal Oil Products Co. and Fish Engineering Co. were awarded design contracts for an olefin



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Building . . .

plant to be operated by El Paso Natural Gas to furnish raw stocks to Rexall's chemical plant.

Pakistan government has approved construction of seven lube blending plants to be built by Standard-Vacuum, Caltex, Burmah Shell and Pakistan companies. Six of the plants with 7,500 tons per year capacity will be built in the Karachi area, and one unit with 3,300 tons will be constructed at Chittagong, East Pakistan.

Hooker Chemical Corp. plans to construct a multi-million-dollar plant in Northern Kentucky to produce synthetic phenol. The unit, located near Portsmouth, will use benzene as a feedstock. Construction will begin later this year with completion scheduled by the end of 1961. The plant will be operated by Hooker's Durez Plastics Division.

E. I. du Pont de Nemours & Co. is beginning a $9-million expansion program at its Seaford, Del., nylon plant. Completion is slated within 12 months.

Israel is planning the construction of a $5.25-million polyethylene plant.

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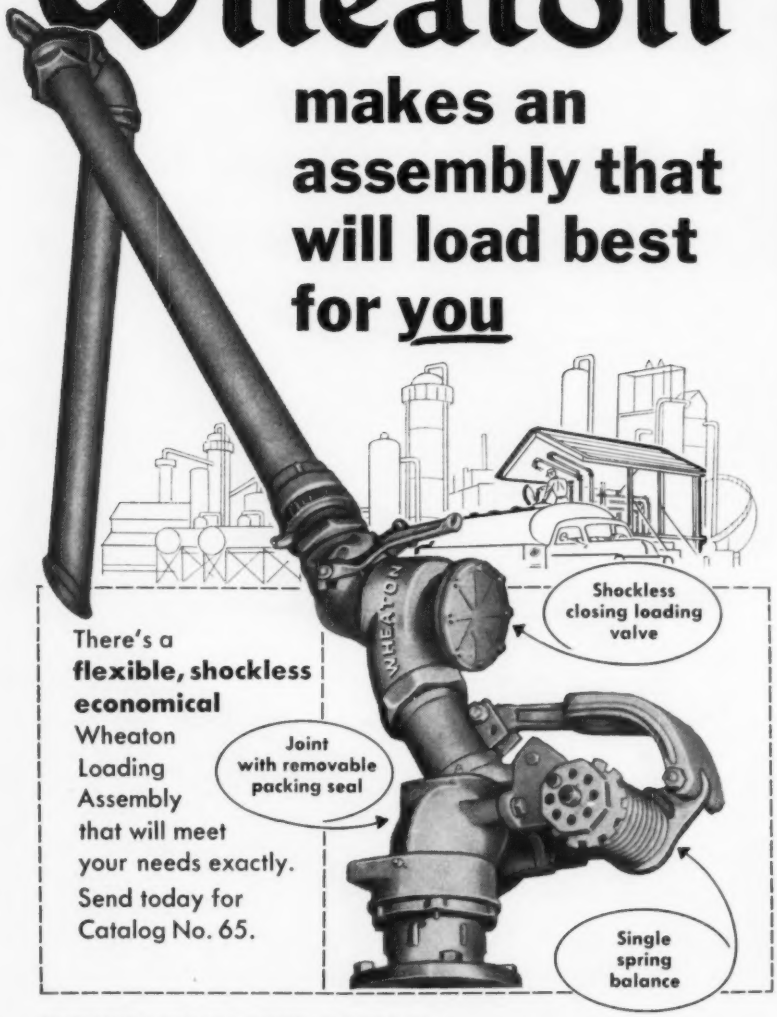

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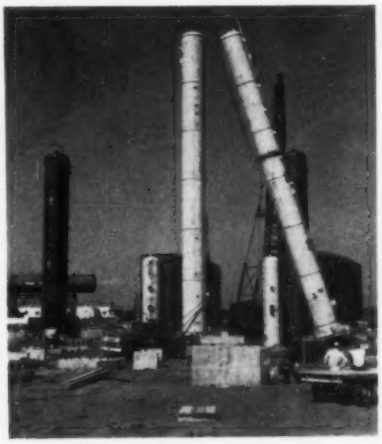
Rimbey, Alta., Gas Plant Gets Debutanizer Vessel

Construction proceeds rapidly on the new Rimbey, Alta., gas plant, as a 78-foot debutanizer vessel is raised into position. The plant, scheduled for fall completion, is 50 miles south of Edmonton. Based on a daily thruput of 326 MMcf of raw gas from the Homeglen-Rimbey and Westerose South fields, the plant will produce daily 68,000 gallons of propane,



98,000 gallons of butane, 325,000 gallons of condensate and 233 long tons of sulphur. Gas contracts with Trans-Canada Pipe Lines, Ltd., and Alberta and Southern Gas Co., Ltd., call for 176 MMcf per day and 104 MMcf per day respectively. The Rimbey plant is owned by 25 companies and is operated by The British American Oil Co., Ltd. (PETROLEUM REFINER, March, 1960, page 250).

Standard Oil Co. (Indiana) will build a waste heat recovery plant at its Whiting refinery. The unit is being added to a revamped and expanded fluid catalytic cracking plant which makes gasoline. The General Engineering Department, Standard's Manufacturing Department, is handling the design of the installation, which is expected to be completed in the spring of 1961. The refinery Mechanical Division will construct the unit.

Bunawerke Huels G.m.b.H. will expand its synthetic rubber capacity of its Marl operation to 120,000 tons per year.

Diamond Alkali Co.'s Chlorinated Products Division is starting the first phase of a long-range expansion program for its plant at Belle, W. Va. Initial con-

For more data on advertised products, use Readers' Service Cards, last page.

Look to Parsons
FOR PERFORMANCE...

PROCESS ENGINEERING...*second to one*

Nature's complex processes... such as transpiration in plants and trees... are superior to those designed by man. But... for experience and for ability in process engineering of man's creations... Parsons is second to none. May we offer you proof of Parsons' performance? Write, on your letterhead, for Brochure 95/17.

The Ralph M. Parsons Company, Los Angeles. United States Offices: Houston, Huntsville, New York, Pasadena, Washington. International Offices: Ankara, Asmara, Baghdad, Bangkok, Cairo, Calgary, Dacca, Jeddah, Karachi, London, New Delhi, Paris, Teheran, Tokyo, Toronto.

WORLD-WIDE SERVICES: PETROLEUM-CHEMICAL ENGINEERING • ARCHITECT-ENGINEERING • CONSTRUCTION • ELECTRONIC SYSTEMS AND COMPONENTS • WATER DEVELOPMENT AND SYSTEMS • APPRAISALS AND ECONOMIC STUDIES • PLANT OPERATION • PERSONNEL TRAINING

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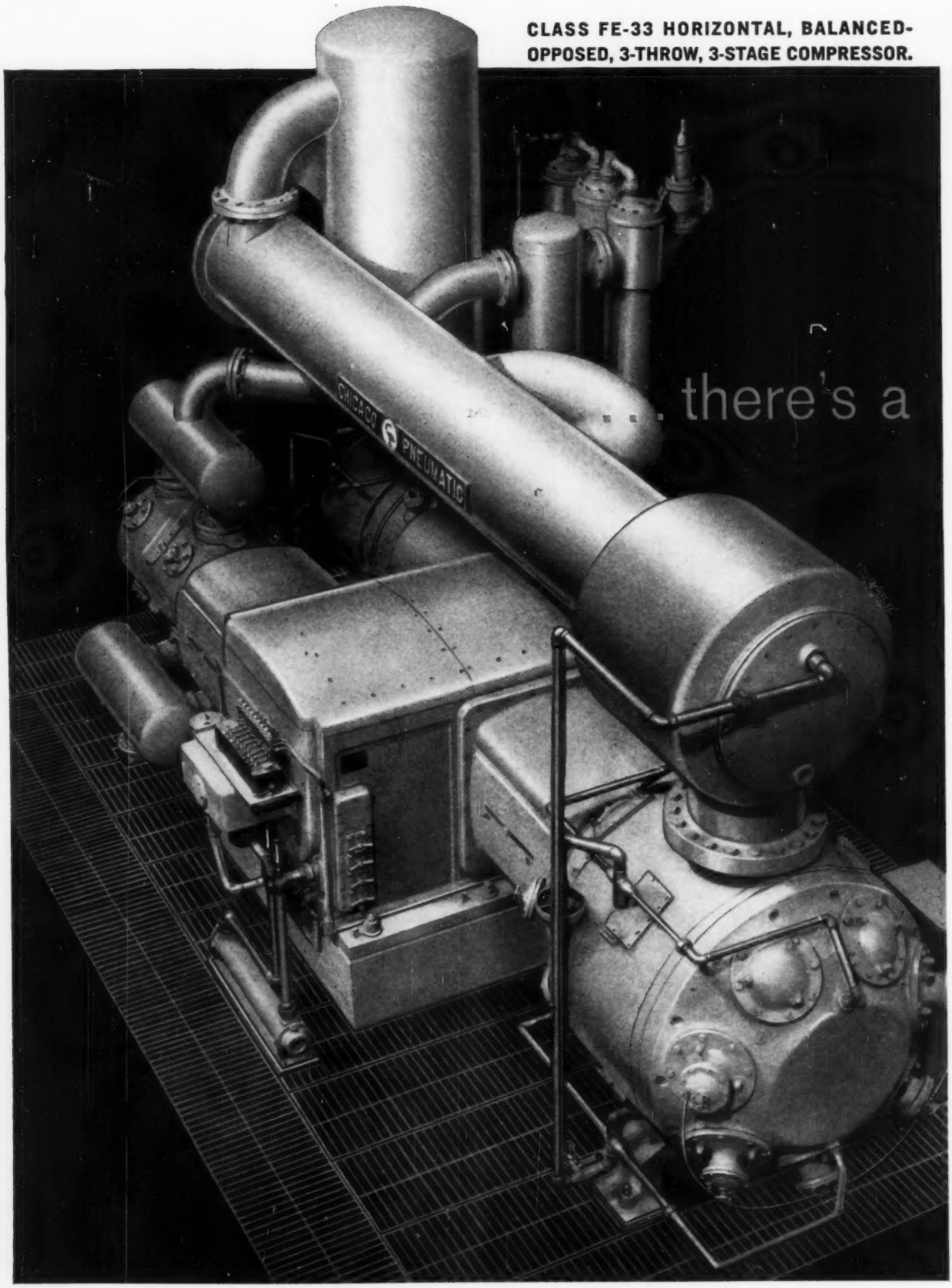

CLASS FE-33 HORIZONTAL, BALANCED-OPPOSED, 3-THROW, 3-STAGE COMPRESSOR.
. . . there's a
CHICAGO PNEUMATIC

whatever your process requirements

CP COMPRESSOR

exactly right for your needs

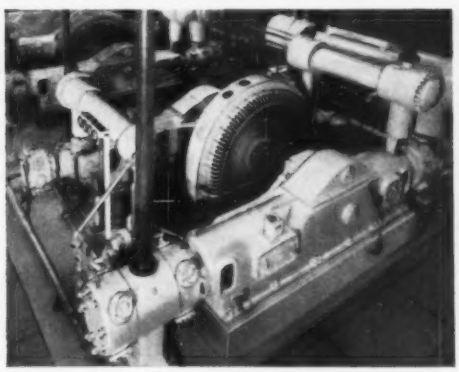
The Class FE horizontal, balanced-opposed compressor is built in a wide range of combinations of crankthrows, cylinder arrangements and stages for pressures up to 15,000 psig; sizes up to 5,000 hp. One such combination is shown at the left.

Other CP Compressors from 7½ hp belt-driven vertical single-acting to 2,000 hp horizontal double-acting with belt, steam or direct motor drive.

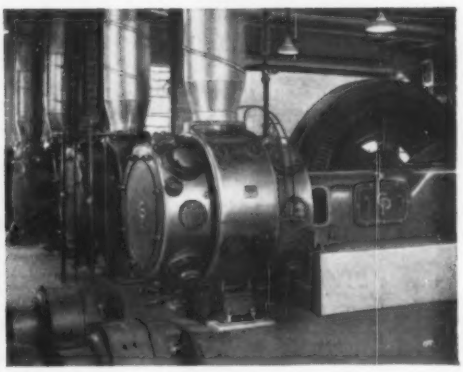
Chicago Pneumatic *8 East 44th Street, New York 17, N. Y.*

Air and Gas Compressors • Vacuum Pumps • Pneumatic Tools • Electric Tools • Diesel Engines • Rock Drills • Hydraulic Tools

Class H, horizontal duplex four-corner, 4-stage.



Class 0-DE, horizontal duplex, double-acting single-stage.



For more data on advertised products, use Readers' Service Cards, last page.

Building . . .

struction will include modernization of the facilities in which the plant makes methyl chloride, methylene chloride and chloroform.

Celanese Corp. will build a 14-million-pounds-per-year 2-ethylhexyl acrylate, butyl acrylate and glacial acrylic acid plant at its Pampa, Texas, site. Completion of the multi-million-dollar expansion is set for late 1960. The new construction is expected to double the Pampa plant's over-all acrylate production.

Golden Bear Oil Co. plans a $350,000-expansion and improvement program at its Bakersfield, Calif., refinery. The plant presently is processing 5,000 bpd of crude, the bulk of which goes into lubricants and lubricating specialties. As part of the proposed expansion, the company will construct laboratory facilities and additional office, shop and storehouse space.

Enjay Chemical Co. and Allied Chemical Corp. plan to expand their facilities for orthoxylene. Capacity of Enjay's Baytown plant will be increased to 72 million pounds from 44 million pounds. Cost of the expansion will be less than $1 million. Allied Chemical will expand phthalic anhydride production capacity at its Philadelphia plant.

Suntide Refining Co., a wholly-owned subsidiary of Sunray Mid-Continent Oil Co., will build a styrene unit at its Corpus Christi plant. The plant's production is expected to reach 60 million pounds annually.

Continental Oil Co. has completed a $1-million-plus natural gasoline construction program in West Texas and New Mexico. The project included a plant 20 miles west of Jal, N. M., with a processing capacity of 5 MMcf daily, and expansion of the Ramsey plant near Pecos.

Union Oil Co. now has construction well under way on its Los Angeles refinery. The four major process units consist of one catalytic reforming unit and three of Union's own catalytic desulfurization units, Unifiners.

Warren Petroleum Corp. has a $1,900,000 modernization and modification program under way at three of its plants. The program will increase total daily production of light hydrocarbons by 70,000 gallons.

A/S Esso-Raffineriet, Norge is in the final stages of construction at its new 40,000-bpd grass roots refinery in Slagen, Norway. The refinery, scheduled to go into operation late this year, will be Norway's first major petroleum refinery.

Ente Nazionale Idrocarburi will build a $64-million petrochemical complex at Ferandina in Southern Italy. The state-owned company will supply the plant with natural gas from discoveries in the immediate area. ENI also has two other petrochemical plants in operation in Italy.

Societe des Elastomeres de Synthese is planning to build a polybutadiene rubber plant near its almost completed 50,000-tons-per-year BSR-type plant outside Marseilles, France. The plant will have a yearly capacity of 25,000 tons.

The Dow Chemical Co. of Canada will produce polypropylene at a new plant at Sarnia, Ont. Construction of the plant, which is expected to produce 12 million pounds per year, should begin by late next year, with completion near the end of 1962.

Sid Richardson Carbon Co. will begin construction of a furnace-black facility at Big Spring, Texas. The plant, which will produce 50 million pounds per

PROVEN BY EXPERIENCE

W. C.
NORRIS
SWAGED NIPPLES *and* BULL PLUGS

Safety . . . craftsmanship . . . durability . . . precision . . . yes, these elements are important in Swaged Nipples and Bull Plugs. And, these are the elements found in *all* W. C. Norris fittings — elements proven by the experience of our customers.

W. C. NORRIS, MANUFACTURER
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NORRIS QUALITY OIL WELL SUPPLIES
P. O. BOX 1739 • TULSA, OKLAHOMA
BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico; Edmonton, Alberta, Canada.
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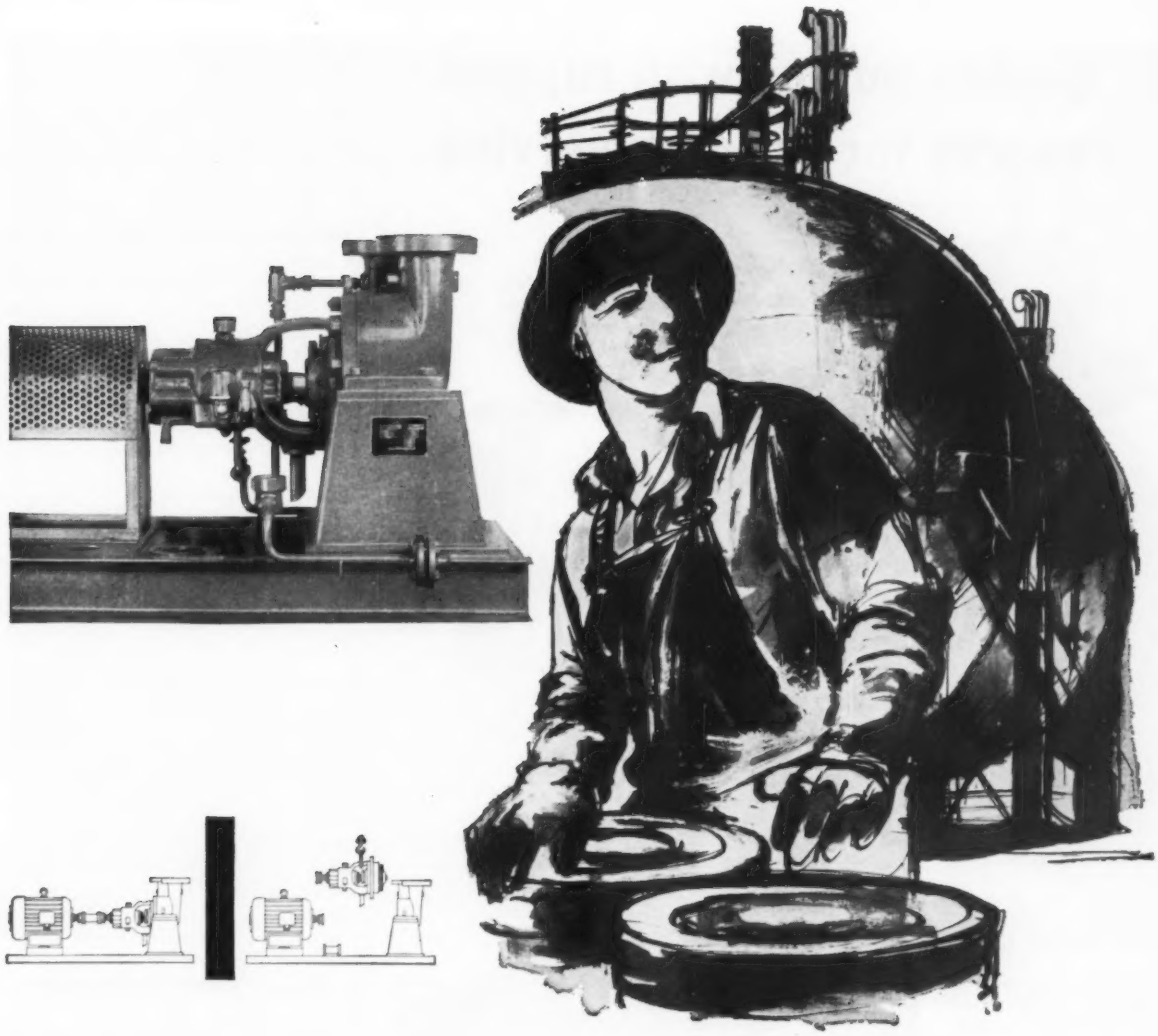


The pump must match the application

The available range of our RPK Process Pumps offers the Oil Industry a selection that fully meets the fundamental requirement stated above.

The special characteristics of this pump are maximum reliability and economical operation at all operating points. Other features are the wide range of capacities and applications, the ease with which erection and disassembly can be carried out, and parts subject to wear renewed. The design includes a high factor of safety.

The parts particularly liable to deteriorate by wear are standardized for the widest possible range of sizes, and thus the maintenance of an adequate stock of spares is greatly facilitated.

Every type of service is catered for in respect of shaft sealing, which may be by means of the conventional packed stuffing-box or one of a great variety of mechanical seals.

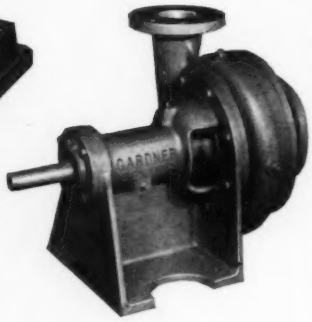
KSB

Klein, Schanzlin & Becker Aktiengesellschaft, Frankenthal (Pfalz) Germany

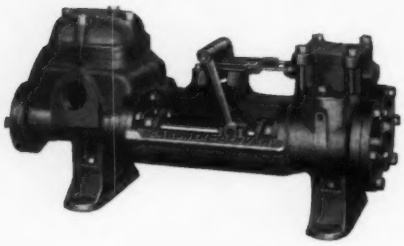
For more data on advertised products, use Readers' Service Cards, last page.

Quality pumps with rugged reserve for refinery service

Gardner-Denver BH—four sizes. Provide range from 55 to 550 gpm. Designed for high-speed, high-head operation.

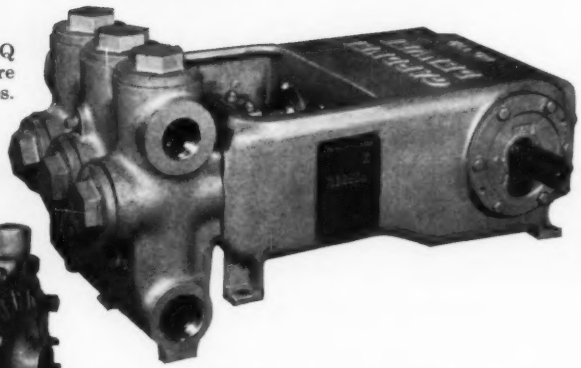


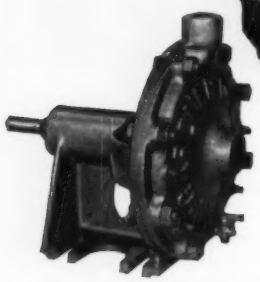
Gardner-Denver BL—five sizes. Provide range from 100 to 1600 gpm. Highly efficient in taking variations in head or volume.



Gardner-Denver duplex reciprocating pumps for operation on steam, air or gas. Eight sizes produce from 9 to 294 gpm.

Gardner-Denver PQ and PS high-pressure triplex plunger pumps. PQ size, 2½x2 . . . PS size, 2¾x2½.





Gardner-Denver CAY 1" reversible circulating pump operates efficiently in either direction. Handles up to 65 gpm.

All Gardner-Denver pumps are engineered with rugged reserve for trouble-free operation and long-lasting duty. Your Gardner-Denver pump specialist can help select the best pump for your requirement. Call him soon, or write for information.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Building . . .

year, will produce HAF and ISAF blacks under a license from United Carbon Co. It is expected to go on stream in mid-1961.

Pakistan Refinery, Ltd., is expected to begin construction in October on its Korangi refinery. The plant is in the planning stages at present.

British Hydrocarbon Chemicals, Ltd., will build a synthetic methanol plant at Grangemouth, Scotland. The construction contract has been awarded Chemical Construction Corp., New York.

Shell Chemical Co. is teaming with Stauffer Chemical Co. and Western States Chemical Co. to construct a fertilizer plant at Dominguez, Calif. The plant, which will be designed to produce 50,000 tons annually, will be completed early next year.

Hungary is constructing a 60,000-bpd refinery near Szazholmobatta, a town south of Budapest. The new unit will be supplied by a pipeline system that will transport Russian crude to four U.S.S.R. satellites in Eastern Europe.

Imperial Chemical Industries, Ltd., plans to expand polyvinyl chloride production capacity at its Hillhouse, Lanca-

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HYDROFINING REPLACES ACID TREATMENT

To eliminate pollution of air and effluent water, reduce operating costs, and to produce a sulphur free finished product, a large Gulf Coast refiner recently placed in operation the above pictured 6000 barrel per day HYDROFINING Unit designed to supplant acid treatment in processing close boiling range naphthas.

Feed stock is vaporized and mixed with hydrogen which catalytically reacts with sulphur contained in the feed stock mostly in the form of mercaptans, to form hydrogen sulphide which is further processed to recover elemental sulphur. After HYDROFINING the liquid product is washed with caustic and filtered through charcoal.

HUDSON furnished mechanical design, materials and equipment; and constructed the HYDROFINING Unit and the Fractionating Unit shown at the left of the picture.

The services of the HUDSON organization, with over 25 years experience in process design, mechanical design and construction are available to process industries in any part of the free world.

DESIGNERS AND CONSTRUCTORS OF PROCESS PLANTS FOR THE OIL, GAS, CHEMICAL, AND MINERAL INDUSTRIES

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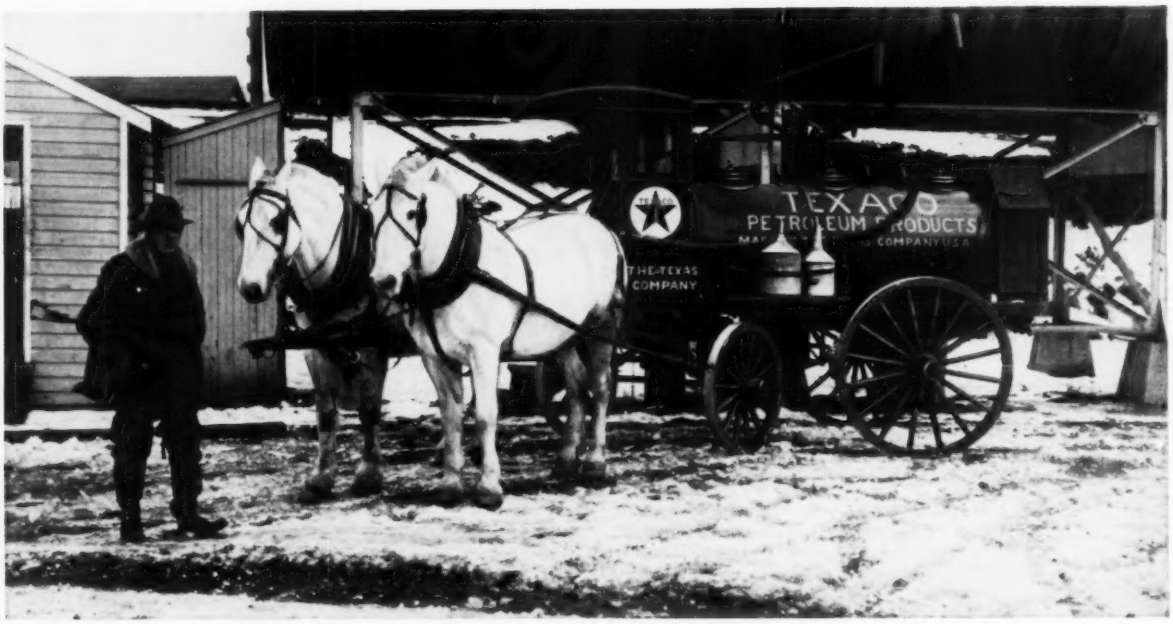
From two horses to 200-horsepower



YESTERDAY—"petroleum" was primarily kerosine, the fuel that fed the lamps and cooking stoves of America. Sold by local grocery and hardware merchants, it was delivered to them once a week. It was Texaco that first met the urgent need for twice-weekly deliveries, with its horsedrawn tank wagons. Daily deliveries soon followed.

TODAY—the chief product of petroleum is gasoline, moved swiftly from storage point to market in giant, modern tank trucks. Today Texaco's fleet of red trucks serves more than 39,000 Texaco Dealer stations across the nation. Alert marketing operations, based on service to America's motorists, have contributed to Texaco's continued growth.

TEXACO

Building . . .

shire plant by 10,000 long tons. Completion is set for mid-1961.

The Firestone Tire & Rubber Co. has started construction of a multi-million-dollar synthetic rubber plant at Port Jerome, France. It will have an initial production capacity of 10,000 long tons per year at its completion in 1961.

Enjay Chemical Co. has completed a project for expanding oxo alcohol capacity at its Baton Rouge refinery by 50 percent. The expansion raises the refinery's capacity to 90 million pounds yearly.

Imperial Chemical Industries, Ltd., is installing a plant to make polyvinylidene chloride copolymers in Great Britain. At present, Great Britain's demand for these resins is met almost entirely by imports. The plant should be in operation early next year.

Standard Oil Co. of Calif. will help to finance a new 12,000-bpd refinery in Peru. The plant will be built at Conchan, 15 miles south of Lima.

Iraq is planning a $56-million refinery at Basrah to have a capacity of 40,000 bpd. Iraq's General Board of Oil Affairs will build the project, which will produce about 12,000 bpd for export. The unit will be completed within five years if the plans are approved this year.

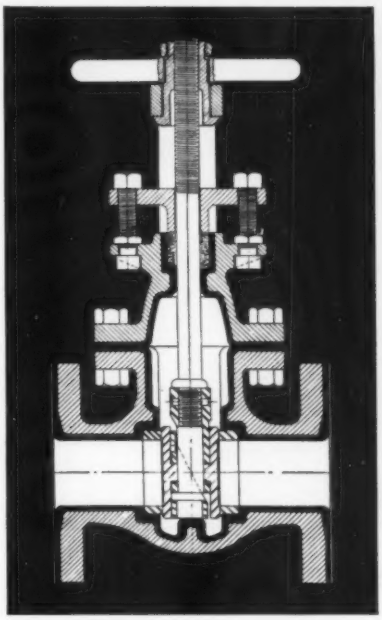
Frontier Refining Co. will expand the capacity of its Beeline refining plant, Salt Lake City, Utah, from 5,500 bpd to 7,500 bpd. The company will also build a terminal in Idaho for receiving Beeline-plant production for the Pacific Northwest market.

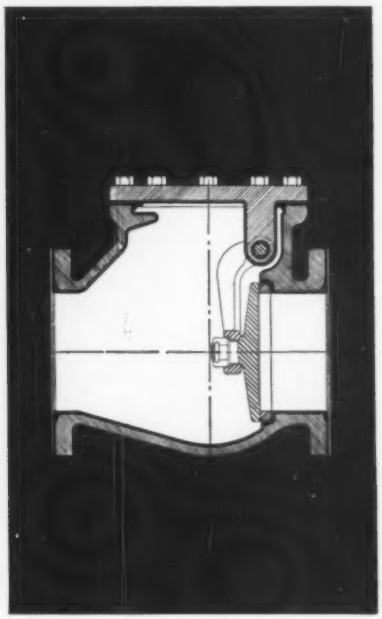
Japan Petrochemical Co. and Oronite Chemical Co. are planning to build a plant at Kawasaki, Japan, to produce 15,000 tons annually of alkyl benzene. Cost of the facility is set at $4.2 million.

Continental Oil Co. is constructing its second commercial Hydrar unit at the Ponca City, Okla., refinery. Hydrar is a

Cost cutters for corrosive service

Why pay for expensive special alloy valves when IRON BODY VALVES with hard rubber lining may solve your problem more economically?





RUBBER-LINED IRON BODY GATE VALVES

In many cases, you can save the cost of expensive alloy valves for corrosive or abrasive service. Darling rubber-lined gate valves offer you these advantages:

1. Iron body substantially reduces cost over special alloy valves.
2. Special hard rubber lining on bodies and bonnets (see diagram) provides high resistance to corrosion and abrasion.
3. Revolving double disc parallel seat and "no pocket" discs provide positive sealing and assure ease of operation.

Available in outside screw and yoke type, in sizes from 2" to 24". Write for further information.

RUBBER-LINED IRON BODY CHECK VALVES

Streamlined body design has been especially selected for application of hard rubber lining. Excess area through the valve minimizes abrasion and assures full delivery of line capacity.

A slight pressure on the pump side of the valve will immediately unseat the disc. Yet valve remains tight when there is no differential pressure on either side of disc.

Interior working parts are made of suitable corrosion resistant alloy. Yet the iron body substantially reduces overall cost.

Designed for 175-lb. working pressure. Available in sizes from 2" to 24". Write for further information.

DARLING VALVE & MANUFACTURING CO.

Williamsport 31, Pennsylvania

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

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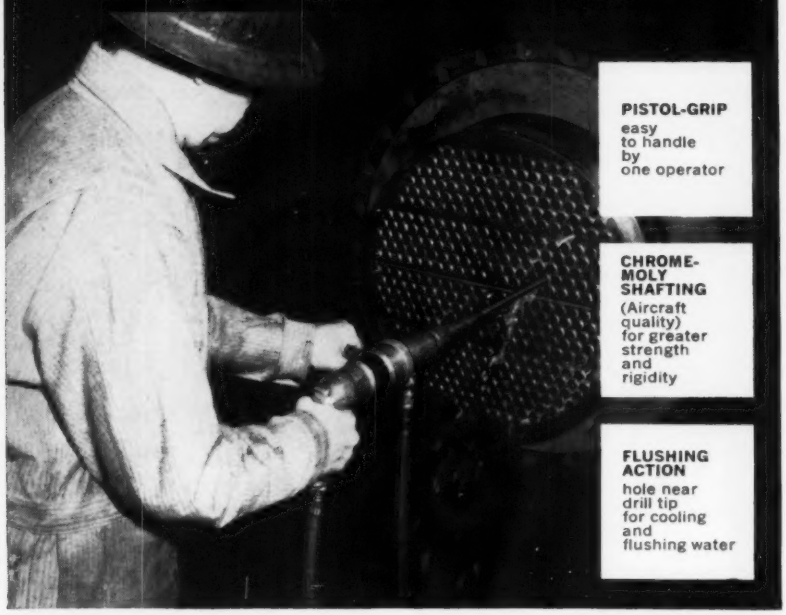
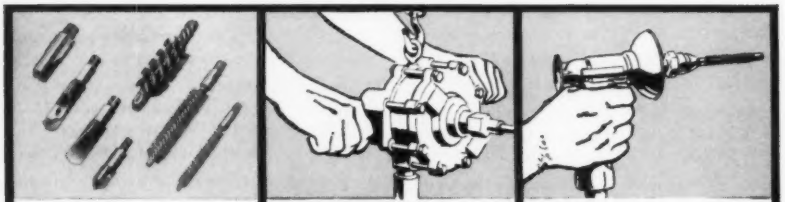
newest ELLIOTT tube cleaner

lightweight! air-driven!


PISTOL-GRIP
easy to handle by one operator
CHROME-MOLY SHAFTING
(Aircraft quality) for greater strength and rigidity
FLUSHING ACTION
hole near drill tip for cooling and flushing water

for condenser and heat exchanger tubes

Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



DRILLS AND BRUSHES FOR VARIED NEEDS
Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

SUSPENSION TYPE
Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.

ELLIOTT JIFFY GUN
For extra-fast cleaning of light deposits in tubes ½ in. to 1¼ in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

ELLIOTT Company
Lagonda Plant—Springfield, Ohio

Y9-1

Building . . .

catalytic hydrogenation process developed by Universal Oil Products Co. for converting benzene, toluene and higher aromatics to their respective cycloparaffins. Procon, Inc., is the contractor for the project.

Standard-Vacuum Oil Co. will build a $30-million refinery near Adelaide, South Australia. Construction of the 37,000-bpd plant is expected to start late this year. The unit should go on stream by the second half of 1962.

Petroleos de Galicia's application to build a 26,000-bpd refinery at Vigo, Spain, has been rejected by Spain's Ministry of Industry.

Texaco Canada, Ltd., will build benzene and toluene facilities at Port Credit, Ont. Estimated cost of the construction is $2 million. Production is slated for 1961. Initial output of the facilities is set at about 1,500 bpd with provision for future production of xylenes and ethyl benzene.

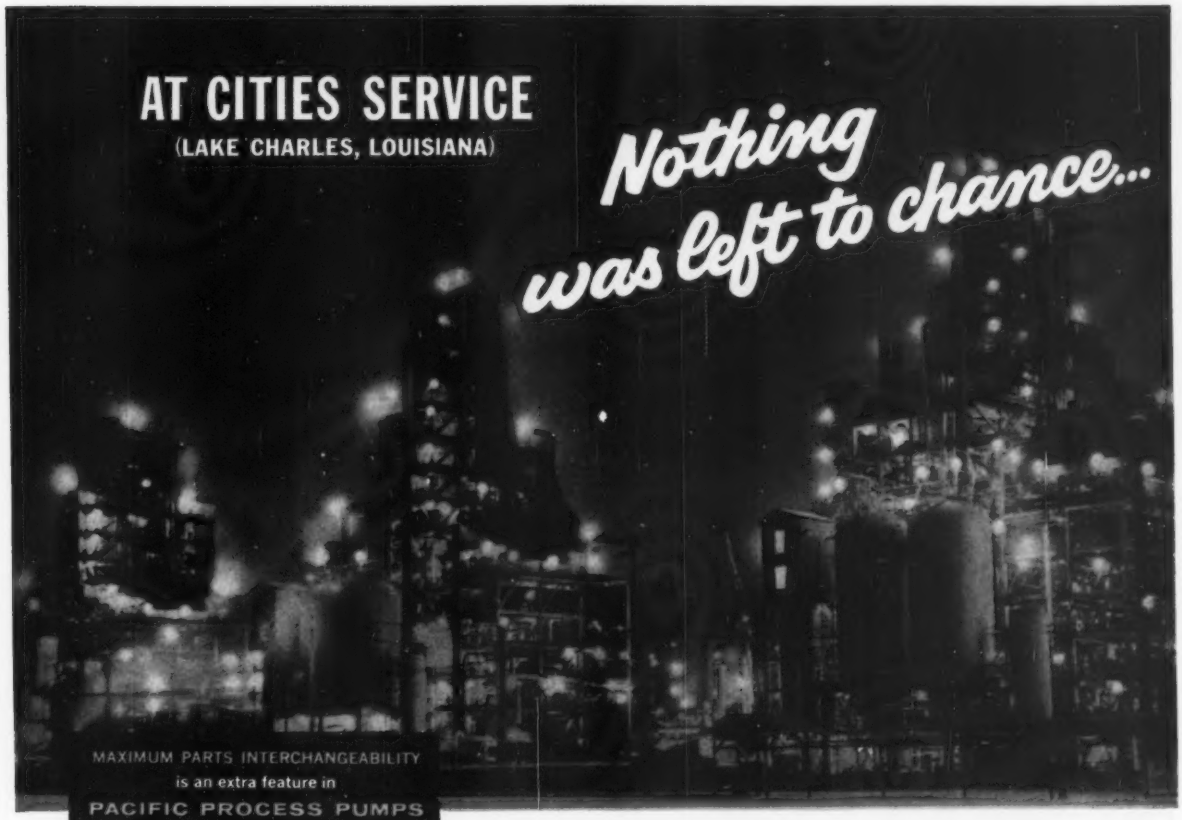
Union Carbide Australia, Ltd., will double planned capacity of its Altona polyethylene plant to 30 million pounds per year.

Allied Chemical Co.'s general Chemical Division will expand its fluorinated hydrocarbons capacity by one-third with the construction of a new plant at Elizabeth, N. J. Completion of the facilities is scheduled for early 1961.

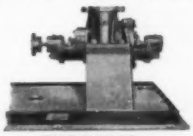
California Spray-Chemical Co. has planned construction of a $22-million nitrogen fertilizer complex at Fort Madison, Iowa, to produce 600 tons per day of complex fertilizers and 300 tons per day of anhydrous ammonia.

Esso Petroleum Co. will expand petrochemical facilities at is Fawley, England, refinery with the addition of steam-crack-

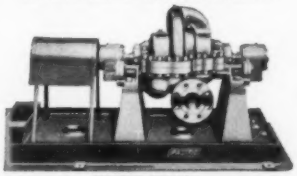
For more data on advertised products, use Readers' Service Cards, last page.



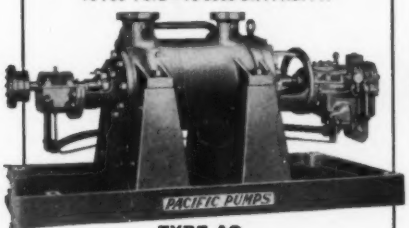
TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.



TYPE AC
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

Practically 100% PACIFIC

process pumps are in service at:

CITIES SERVICE REFINERY
PETRO-CHEMICAL, INC.
CIT-CON, INC.

The three fluid catalytic crackers illustrated have established new records for continuous operation since going on stream. Under the most demanding service conditions, all three units came through remarkably. Number two unit operated for 1058 consecutive 24-hour days only to be outdone by its sister unit with a record of 1065 days continuous operation. We feel that the 100% Pacific installation (including slurry pumps) contributed to making these run-records possible.

Elsewhere throughout Cities Service, P.C.I. and Cit-Con operations, Pacific process pumps are delivering equally dependable 'round-the-clock service...convincing evidence that "nothing was left to chance."

Write for Complete Line Bulletin 1C plus individual bulletins for pumps illustrated in panel.

PACIFIC

PACIFIC PUMPS INC

A Division of Dresser Industries, Inc.
HUNTINGTON PARK, CALIFORNIA

CP-20

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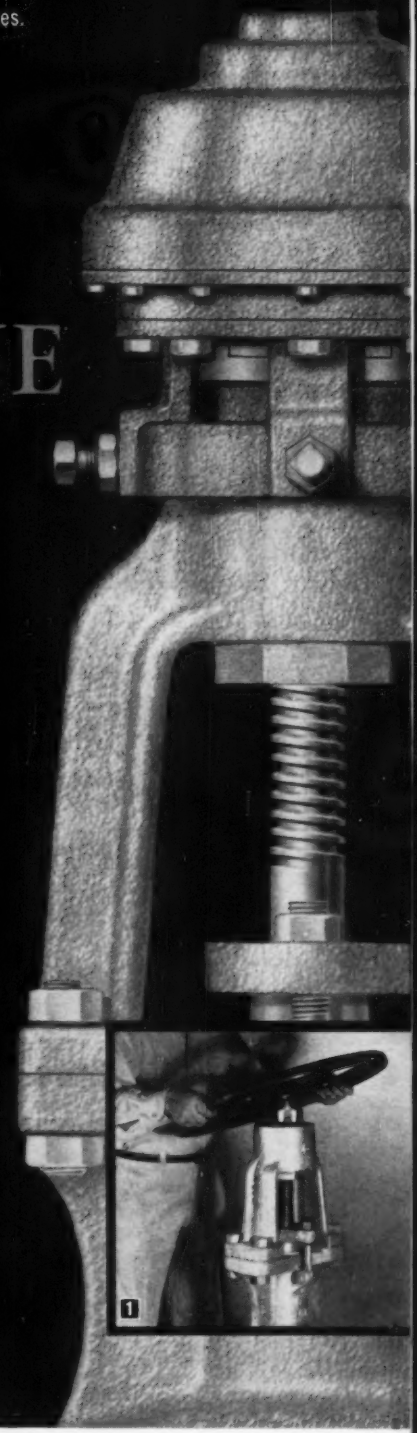
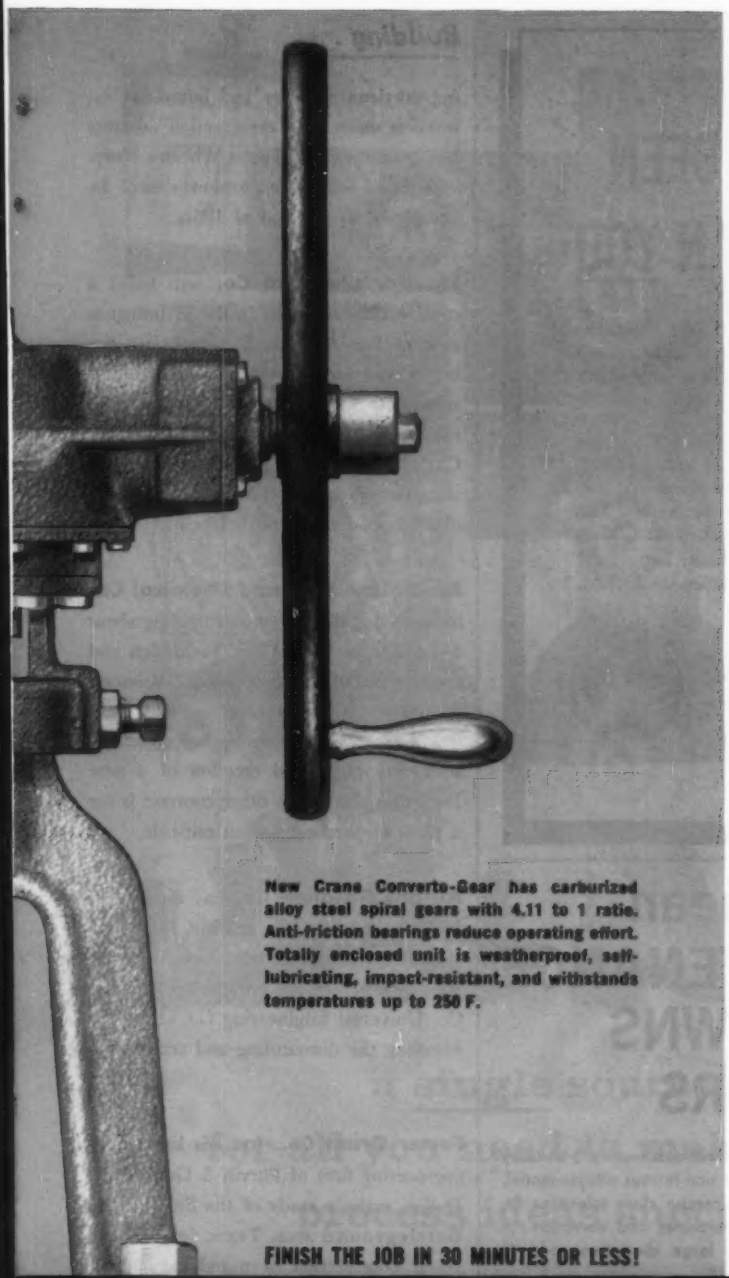
CRANE
DIRECTION '70

. . . a fast-moving program of planned expansion, product development, and streamlined distribution to help our customers meet the competitive challenges of the Sixties.

NEW! You can order this CRANE Converto-Gear Valve Operator from stock... install it in less than 30 minutes





New Crane Converto-Gear has carburized alloy steel spiral gears with 4.11 to 1 ratio. Anti-friction bearings reduce operating effort. Totally enclosed unit is weatherproof, self-lubricating, impact-resistant, and withstands temperatures up to 250 F.

Only three parts needed to convert your OS & Y valve to gear operation: (a) Crane Converto-Gear Operator, (b) adapter for mounting operator on valve, (c) yoke sleeve adapter. Handwheel and mounting bolts furnished with conversion kit.

Now you can convert to rapid, easy gear operation on many of your Crane iron and steel gate valves without removing them from the line! Changeover is simple and fast with Crane's new Converto-Gear Operator.

Your Crane Distributor can give you complete information on this brand-new idea in gear operators for gate valves. The Converto-Gear is standard and universal, readily mounted on Crane iron and steel gate valves in sizes from 6-inch to 36-inch, in outside screw and yoke or non-rising stem patterns.

And new orders for gear operated valves can be filled with unprecedented speed because the Converto-Gear can be supplied on valves right from stock. No special yoke castings or brackets are needed . . . just the basic gear operator and a simple two-piece adapter.

CRANE®

CRANE CO. INDUSTRIAL PRODUCTS GROUP
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VALVES • ELECTRONIC CONTROLS • PIPING
PLUMBING • HEATING • AIR CONDITIONING
HEAT EXCHANGERS • CYCLOTHERM (R) BOILERS

FINISH THE JOB IN 30 MINUTES OR LESS!

To convert your OS & Y valve, (1) remove the handwheel, (2) mount the yoke sleeve adapter, (3) countersink 4 holes for the Converto-Gear adapter, (4) bolt the adapter in place and attach your Crane Converto-Gear Operator, (5) and you're ready for smooth, manual operation, (6) or fast operation with an air or electric power operator.

MANY FAST'S HAVE BEEN WORKING LONGER THAN YOU

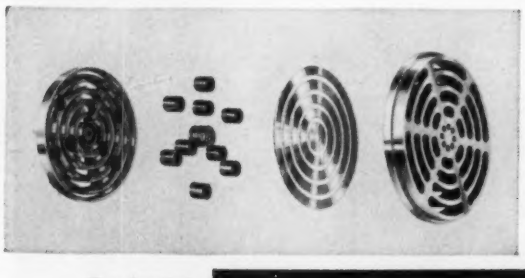
It's a fact. There are plenty of cases where Fast's Couplings have been in service 20 to 40 years. And some of our more enthusiastic engineers say a Fast's should last forever if it's properly applied, installed and lubricated. Whatever opinion you accept, you can bet Fast's Couplings will give you the same smooth-running, low-maintenance, long-lived performance that makes them the choice of more equipment manufacturers than any other gear-type coupling.

For example, Fast's Coupling No. 1347, shipped in July, 1922, is still in service—and the customer is just ordering his first spare coupling 38 years later. KOPPERS COMPANY, INC., 1509 Scott Street, Baltimore 3, Md.

KOPPERS **FAST'S COUPLINGS**
Engineered Products Sold with Service

VOSS VALVES will mean LESS MAINTENANCE FEWER SHUTDOWNS for your COMPRESSORS

Voss Valves are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. Plates are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. Springs of heavy rectangular sections and large diameters add to dependability and safety.



- up to 40% more valve area
- minimum pressure loss
- higher efficiency
- less power consumption
- normal discharge temperature
- quiet, vibration-free
- utmost safety
- lower operating costs

For detailed proposal send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.
J. H. H. VOSS Co., Inc.
785 East 144th Street,
New York 54, N. Y.

Building . . .

ing ethylene recovery and butadiene extraction units. The construction contract has been awarded Foster-Wheeler Corp. The $15.4-million expansion should be completed by the end of 1961.

Stauffer Chemical Co. will build a captive chlorine plant in the Wilmington area of Los Angeles. Engineering has begun and completion of the plant is scheduled for late next year. Total chlorine output will be supplied to American Chemical Corp. as a raw material for the manufacture of vinyl chloride, ethylene chloride and ethylene dichloride.

Food Machinery and Chemical Co. has awarded three contracts totaling about $4 million to Fluor Corp. for design and construction of new facilities at Baltimore, Md. Two contracts cover expansion of FMC's Dimazine unsymmetrical dimethylhydrazine plant and erection of a new Dimazine plant. The other contract is for a plant to produce Tedion miticide.

Aurora Gasoline Co. has dismantled its 10,000-bpd refinery at Elsie, Mich., for shipment to Genoa, Italy. New owner of the plant will be the Sanquirico Refinery Co. Universal Engineering Co. crews are handling the dismantling and reconstruction.

Foster Grant Co., Inc., is having the engineering firm of Purvin & Gertz, Inc., Dallas, make a study of the San Jacinto Battleground area, Texas, for the proposed construction of a nylon plant to cost in excess of $5 million.

Oronite Chemical Co. and Nippon Petrochemicals, Ltd., plan to build a detergent polymer and alkylate plant at Kawasaki, near Tokyo. The facility will be operated by Nippon Detergent Co., in which Oronite will hold 45 percent interest.

Montecatini Co.'s wholly-owned American subsidiary, Novamont Corp., is handling expansion construction of the

For more data on advertised products, use Readers' Service Cards, last page.

a single source for all you need to make your process ideas succeed

Your ideas will thrive best in the company of people experienced in developing the ideas of others.

At Foster Wheeler you will find everything you need to make your process ideas a commercial success. There are men skilled in laboratory research and commercial evaluation to probe the practical possibilities of your ideas. To design and engineer your process plant there is a community of engineering professions—structural, heat and power, chemical, hydraulic, process . . . experts on pressure vessels and instrumentation . . . and people experienced in project management, plant construction and start-up.

From this comprehensive approach you can expect profitable operation at rated capacity soon after completion.

Two recent examples are plants delivered in good time and in good working order, operationally ready for quick write-off. They are a new ammonia plant producing in excess of 300 ton/day that exceeded rated capacity within 30 days of start-up; and a complete lube oil plant built in the Middle East which was in full production less than two years after award of the contract.

Before you specify, consult with Foster Wheeler. We are ready when you are. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

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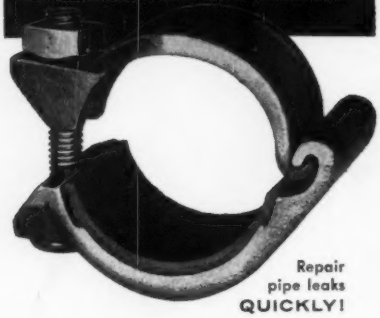
For Speediest Repair of Corrosion Leaks in Pipe

JUNIOR

EMERGENCY PIPE CLAMP

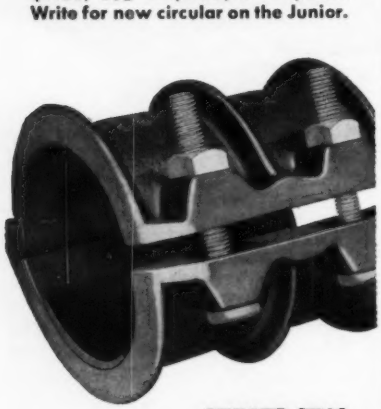


Repair pipe leaks QUICKLY!

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full-length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write for new circular on the Junior.



SKINNER-SEAL

EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

Send for catalog!

M. B. SKINNER CO.

SOUTH BEND 21, INDIANA

Building . . .

company's Neal, W. Va., polypropylene plant. The unit has been expanded from 10 million pounds to 25 million pounds yearly.

Petroleos Mexicanos has signed an agreement with Soc. Lavorazioni Organiche, an Italian firm, to build a tetraethyl lead plant in Mexico. The project will cost in excess of $10 million.

Czechoslovakia is to build two refineries with a yearly capacity of about 16,500 bpd for the United Arab Republic. The first project will be set up in Alexandria, the second alongside the Suez Canal.

DX Sunray Oil Co. plans to build an 85,000-bpd crude distillation unit at its Tulsa refinery. The new construction will replace five units that have a combined capacity of 75,000 bpd.

Allied Chemical Corp. plans to build a plant at Baton Rouge, La., to make 20 million pounds yearly of polyethers. Unit production is expected to begin by mid-1961.

Continental Oil Co. has completed a KMA natural gasoline plant near Electra, Texas. The project includes replacement of an outdated absorption oil unit with a refrigeration-type natural gasoline processing plant.

Phillips Chemical Co. is planning a $2-million to $3-million expansion of its polyethylene plant near Pasadena, Texas. The expansion will add 25 million pounds of polyethylene production a year to give the plant an annual capacity of 100 million pounds.

Texas Gas Exploration Corp. and Runnels Gas Products Corp. are enlarging their Eunice, La., natural gas extraction plant to 800 MMcfd, twice its 1959 capacity. The facility was placed on stream in December 1957 with a capacity of 300 MMcfd. It was increased for the first ime in 1959, to 400 MMcfd.

Allied Chemical Corp.'s National Aniline Division has awarded The Lummus Co. a contract for design, engineering and procurement of a major caprolactum monomer project at Allied

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I.Q."* of engineers . . . (*"Income Quotient")

"LOW FIRST-COST VS. LOW ULTIMATE COST" CONTROVERSY DEMANDS UNDERSTANDING OF ECONOMICS

In the price-economy of competitive bidding, especially in the field of capital process equipment, the historic struggle between long-range economy and "low-dollar" first-costs has been brought into sharp focus by modern cost engineering practices. Calculating and evaluating the eventual profitability of such equipment can no longer be a matter of "guestimates" or conjecture. The practical facts of economic life must be faced. Process companies must scrutinize closely ALL the factors concerned in engineering, construction, installation and **continued operation.** Unanticipated maintenance or replacement costs can quickly increase the cost of operation, and supposed first-cost savings are thus virtually or entirely eliminated.

Why is "cost engineering", or engineering economics an exotic term to most engineers? This is the Age of Specialization, and so it follows, given free rein, over-design frequently occurs. At the other extreme is the "gimmick pushers" approach that anything will suffice if the price is right. Between these two extremes the dedicated engineer must establish parameters that will satisfy to the highest degree the three M's of industry — Men, Materials, and Means.

Faced with these problems, then, how can we best solve the problem: "When is a low bid really low?" A multitude of answers must contribute to the total solution. What is the longevity of the equipment? How many spare parts will be required? How often will shut-down be required to make repairs? How much time will be required? What are the economic consequences of shutting down the continuous flow operation?

Cost-and-economy consciousness is of prime concern in each stage of process equipment manufacture — from design through fabrication, and finally to installation and operation. All aspects of true costs must be considered, not simply those which are obvious at the moment.

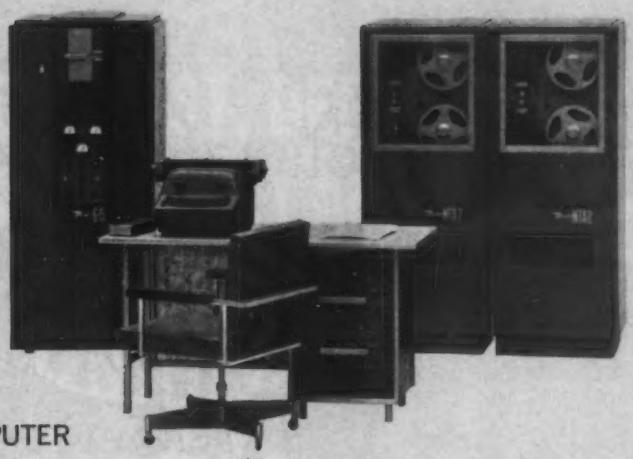
Infinite care must be exercised when considering the following:

Design — a major factor involved in the creation of process equipment. During the design phase, the greatest waste often results from a desire to be conservative. True economy in design must, therefore, satisfy the criteria which apply to each particular process.

Payout — management is interested in equipment that will pay out in the shortest period of time, and this would seem to indicate buying only what is required, at the lowest cost, at the time it is needed. Again, however, the life of the equipment, its maintenance, shut-down time and other factors cannot be ignored.

Excess-capacity — each piece of equipment must be designed for its specific use in order to obtain maximum benefit of capital dollars. Excess-capacity equipment, purchased without specific anticipation of future expansion, represents idle investment dollars.

Today's fierce competition requires the concentrated application of both short and long term economies, from design through final construction and operation. **This subject is treated in more detail in a new booklet, "Low Ultimate Costs and Low Dollar Bids Are Not the Same", and single or multiple copies are available by writing WESTERN SUPPLY COMPANY, P. O. Box 1888, TULSA, OKLAHOMA . . . where the teamwork of science, engineering, technology and economics are combined to provide the optimum in the "cost-engineered" heat exchangers in your future.**



ALGO*

FOR THE BENDIX G-15 COMPUTER

Speeds and Simplifies Problem Solving

ALGO extends the problem-solving horizon of every engineer, focusing the speed and precision of the Bendix G-15 computer on any algebraically stated problem. ● A true mathematical equation solver, ALGO permits any engineer or scientist to program the computer in universal mathematical language. No previous knowledge of computers or programming is needed. Input/output, computation and data handling are all automatically controlled by the G-15 computer. ● Compare the number of steps in the ALGO program illustrated below with the number required to solve the same problem on a slide rule, desk calculator or any other computing system. You will see the time and cost-saving significance of this new Bendix G-15 automatic programming aid. ● Specifically designed to take advantage of the computing power and flexibility of the proven G-15, ALGO is the newest addition to an extensive library of Bendix automatic programming systems. See how the low-cost Bendix G-15 and ALGO combine to broaden application boundaries. Learn how this powerful team can save you valuable time . . . and greatly simplify problem solving.

* AN ALGEBRAIC COMPILER BASED ON INTERNATIONAL ALGOL.

PROBLEM: $$I = \frac{E}{\sqrt{R^2 + (6.2832\,FL - 1/6.2832\,FC)^2}}$$

(For values of R F & L as specified. For values of E ranging from 100 to 300 in increments of 50. For values of C ranging from .00002 to .000021 in increments of .0000001)

COMPLETE ALGO PROGRAM:

```
BEGIN ⑤
R = 10 ⑤
F = 60 ⑤
L = o2 ⑤
FOR E = 100(50)300 BEGIN ⑤
FOR C = o00002(o0000001)o000021 BEGIN ⑤
I = E/SQRT(R ↑ 2 + (6o2832 * F * L — (1/(6o2832 * F * C))) ↑ 2) ⑤
PRINT (FL) = E ⑤
PRINT (FL) = C ⑤
PRINT (FL) = I ⑤
```

Write on your letterhead for the self-teaching ALGO manual.

Bendix Computer Division
DEPT. G-23 LOS ANGELES 45, CALIF.

THE Bendix CORPORATION

Why Solar designs industrial gas turbines to weigh between 1 and 1½ lb/hp

by Paul A. Pitt
Chief Engineer
Solar Aircraft Company

The weight of Solar gas turbines is the result of a design philosophy that is unique in the small gas turbine field.

Most gas turbine designs fall into one of two extreme categories. Aircraft-type engines, at one extreme, embody highly sophisticated techniques for extreme light weight in relation to horsepower, but have resulting short life. The opposite philosophy employs the ultra-massiveness of steam turbines to assure long life.

There are important disadvantages in both approaches when long life, reasonable cost, dependable operation, simple maintenance and easy transportation and installation are required. While aircraft-design engines (of ¼ to ½ hp/lb) can be modified and derated for longer service life, the resulting product is inherently delicate. This compromise inevitably results in short life.

Paul A. Pitt

On the other hand, massive design (of 10 lb/hp and up) leads to unnecessary structural bulk and introduces problems of thermal lag and distortion.

Since World War II, Solar has designed and built a variety of gas turbine units with characteristics that lead to both long life and low weight. The Saturn gas turbine engine, for example, is an 1100 hp unit intended specifically for industrial and military installations. It has a weight-to-power ratio of 1.1 to 1.4 lb/hp.

Although it is designed for long life, it utilizes only enough materials in its components to satisfy structural and thermal requirements. This approach resulted in a design that makes no compromises with durability and performance, yet meets the needs of industry for flexibility in a small package. It has an 1100 hp rating at a specific fuel consumption of 0.61 lb/hp-hr and a continuous rating of 1020 hp at 0.63 lb/hp-hr SFC.

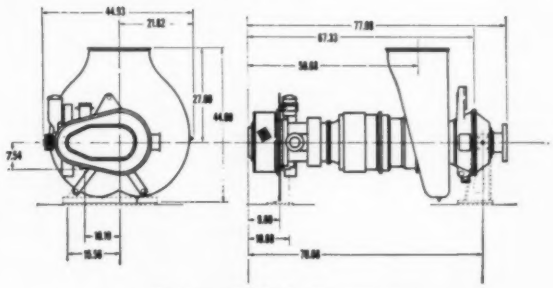
Meeting these objectives required an engine with a simple thermodynamic cycle and high efficiency components. An axial compressor was designed with an operating efficiency of 86%, and this was combined with a multi-stage, axial type turbine of advanced aerodynamic design. Over-all dimensions of the engine are shown in the figure below.

To fulfill workhorse service requirements, the engine was designed to operate at a conservative gas temperature of 1450 F continuous rating. The stress levels are also low, so that major rotating and stationary components will have more than 100,000 hours of life with long periods between overhaul. To keep costs down and assure dependability, the engine design is simple and straightforward.

In brief, the development program of the Saturn turbine adhered to three principles: Careful aerodynamic design for high performance; use of moderate temperatures and low stress levels for long life; and exhaustive component testing for ruggedness and reliability.

Presently scheduled field applications of the Saturn turbine include: Power source for 750 kw electric generator sets in process plants, portable field equipment, pipeline pumping, and gas compression in the petro-chemical industry. Other uses are as a power source for a 600 kw generator set in a commercial marine installation, propulsion units for marine and amphibious vehicles, and prime movers for off-highway vehicles.

Detailed data on Solar gas turbines and other turbomachinery is available. Write Dept. H-152, Solar Aircraft Company, San Diego 12, California.



Saturn T-1000 dimensions

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company

Building . . .

Chemical's Hopewell, Va., plant. Construction has begun on the plant facility, with completion scheduled for mid-1961. The expanded unit will use Allied Chemical-produced phenol as a raw material to manufacture the caprolactum monomer which, in turn, will be utilized in other Allied plants for the production of Nylon.

Miike Gosei Chemical Industry Co., Ltd., Ohmuta City, Kyushu, Japan, will build a maleic anhydride plant using the Scientific Design process of fixed-bed, catalytic, air oxidation of benzene. Plant design capacity will be 8 million pounds of maleic anhydride per year. Scientific Design, in addition to complete process design, will help Miike Gosei in setting standards and specifications, with design of the plant and equipment, and will assist during project engineering, construction and operation.

N. V. Transicol, a Netherlands subsidiary of Heyden Newport International Corp., is starting construction of a new plant to supply the catalyst needs of Europe's synthetic rubber production. The catalyst, PMHP or para-menthane hydroperoxide, is used to control the polymerization rate in the production of styrene-butadiene rubber. PMHP is made from dipentene, a terpene hydrocarbon originating in naval stores manufacture. PMHP has been used in the United States since 1953 as a catalyst for both synthetic rubber and plastics. The new facilities will be located in Geertruidenberg, Holland, at Transicol's existing plant site. N. V. Transicol, purchased by Heyden Newport early in 1960, is a leading manufacturer of paper size in Holland.

Test Yourself

(Answers to Quiz on Page 327)

CASE 1

Arbitrator Robert S. Thompson ruled: "The testing procedure used here is discriminatory. At its whim, the company picks out some aspect of the job and uses it as a 'test.' In this way, just by luck or chance, a junior employe might get a job over a senior man. I cannot accept the assumption that there must be initial competence in every and all aspects of a job. If a senior employe is generally competent, he should be given a chance to work out on a new job. A test cannot be used as the sole reason for turning a man down unless it says so specifically in the union contract. Jim Harvey should get the promotion."

CASE 2

Arbitrator August G. Eckhardt ruled: "Under the company policy, once an employe is entitled to seniority, he computes the time from the date he be-

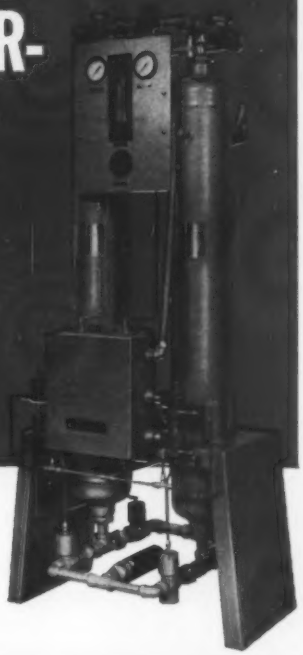
FOR

LOW COST, DEPENDABLE INSTRUMENT AIR-

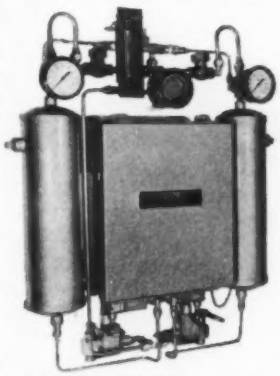
TRINITY

Heat-Les

DRYERS



Increase dependability and accuracy of measurement and control in your system by specifying a dependable Trinity Heat-Les Dryer. These amazing dryers, operating on a principle so simple, yet so efficient, are establishing unparalleled operating records in over a thousand installations.

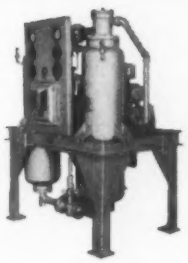


Trinity Heat-Les Dryers are available in standard models ranging from 2 SCFM to 5000 SCFM. Units up to 200 SCFM are available from stock

- ★ Low initial cost
- ★ Completely eliminates costly electric or steam heaters
- ★ No increase in effluent gas temperature
- ★ Low installation costs
- ★ Low operating and maintenance costs
- ★ Built-in safety system provides dry air for extended period after power failure.

ALSO HEAT-REACTIVATED DRYERS

Trinity also offers a complete range of capacities in heat-reactivated type dryers of an advanced design, offering the greatest economies and performance for this type dryer... **WRITE FOR COMPLETE TRINITY DRYER AND ACCESSORY TECHNICAL MANUALS...**



TRINITY World leader in dry gas/air systems

Heat-Les Dryers • Heat-reactivated Dryers
Thermocouples and Thermowells

TRINITY EQUIPMENT CORPORATION, CORTLAND, NEW YORK

For more data on advertised products, use Readers' Service Cards, last page.

CB&I serves the petroleum industry..

processing structures

CB&I offers a single source and responsibility for the engineering, fabrication and erection of petroleum processing structures. These *coordinated services* are the reason why leading refiners rely again and again on CB&I for efficient equipment necessary to their operations.

If *you* demand imaginative engineering . . . strict metallurgical control . . . careful customizing of structure to *process* . . . place your confidence in CB&I.

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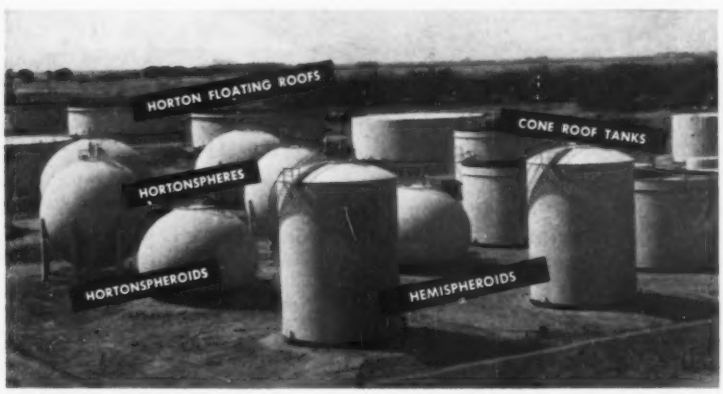
CB&I has grown up with the petroleum industry, always striving to develop better methods of storage. Thousands upon thousands of CB&I-built storage and process vessels serving refineries throughout the world prove our capabilities are second to none.

Every CB&I structure is backed by experience gained from more than seven decades devoted to *Craftsmanship in Steel*. Write for additional information.



Left—Catalytic cracking unit at a Pacific Northwest refinery. The reactor, regenerator, catalyst hoppers and fractionator were built by CB&I and furnished through Bechtel Corporation.

Above—The wide variety of CB&I-built structures meet almost any storage need . . . for high or low pressure, in gas or liquid form.

CHICAGO BRIDGE & IRON COMPANY

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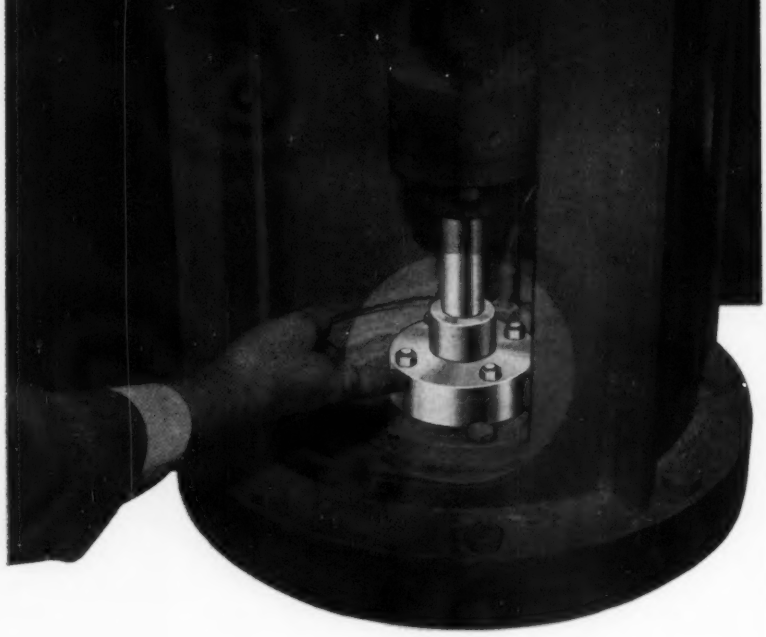
CHICAGO 4, ILLINOIS

OFFICES AND SUBSIDIARIES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

P67SC3

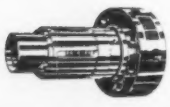
this simple seal gives lowest pump maintenance...

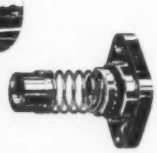


Save up to 66% of the time—expensive downtime—needed for installation or service of other mechanical seals used in plant process equipment.

The simple, effective Borg-Warner Type U Seal has no set screws—no close spring tension adjustments. It's fast and reliable.

For plants with a wide variety of pump service requirements, a minimum inventory of parts, and an easy change of gaskets adapts the Type U seal for service at temperatures of from −100 below zero to +650°F, and for pressures from 0 to 1000 psi.





Backed by Borg-Warner and proved in service, these dependable seals give complete safety, even in unattended stations.

Send for the latest Type U Seal engineering information—there's no obligation.

A PRODUCT OF B-W BORG-WARNER

Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

gan to work for the company without deducting time lost due to any reason. Clearly the language means that even though a foreman does not have seniority as a foreman, if he reaches a situation where he does have seniority, then the time spent as foreman will count toward the total seniority time.

"It is the award of the arbitrator that the grievance be denied and that under the terms of this agreement, employes who acquire seniority within the bargaining unit and who transfer to jobs as foremen outside that unit, and who later transfer back into the unit, have, as of the date of their return to the bargaining unit, seniority from the first date they began to work for the company."

Industry Quiz

(Answers to Quiz on Page 20)

1. False. Though no new thermal units have been built recently, they still account for about 30% of the total cracking capacity. See cracking section, Page 181, for description and flow diagrams for each licensed process.

2. False. Gasoline quality is a secondary purpose, the primary purpose for catalytic cracking being to produce more gasoline from a barrel of crude.

3. True. The entire process under Shell license is described on Page 190.

4. True. It extends cracking time so that coke is formed instead of minimized as in thermal or catalytic cracking. Two coking processes are described on Pages 195 and 196.

5. (b) 43% to be exact. See Pages 201-214 for the processes available.

6. True.

7. (a) 95. See Pages 215-220 for description of alkylate processes available.

8. True. See Pages 221-228 for the way isomerization processes work.

9. False. Most refiners have found their catalytic reformers produce enough hydrogen to satisfy present needs. See the section on "Treating with Hydrogen" (Page 233) for processes available.

10. True. See Pages 257, 263, and 264 to see how these crudes are desalted.

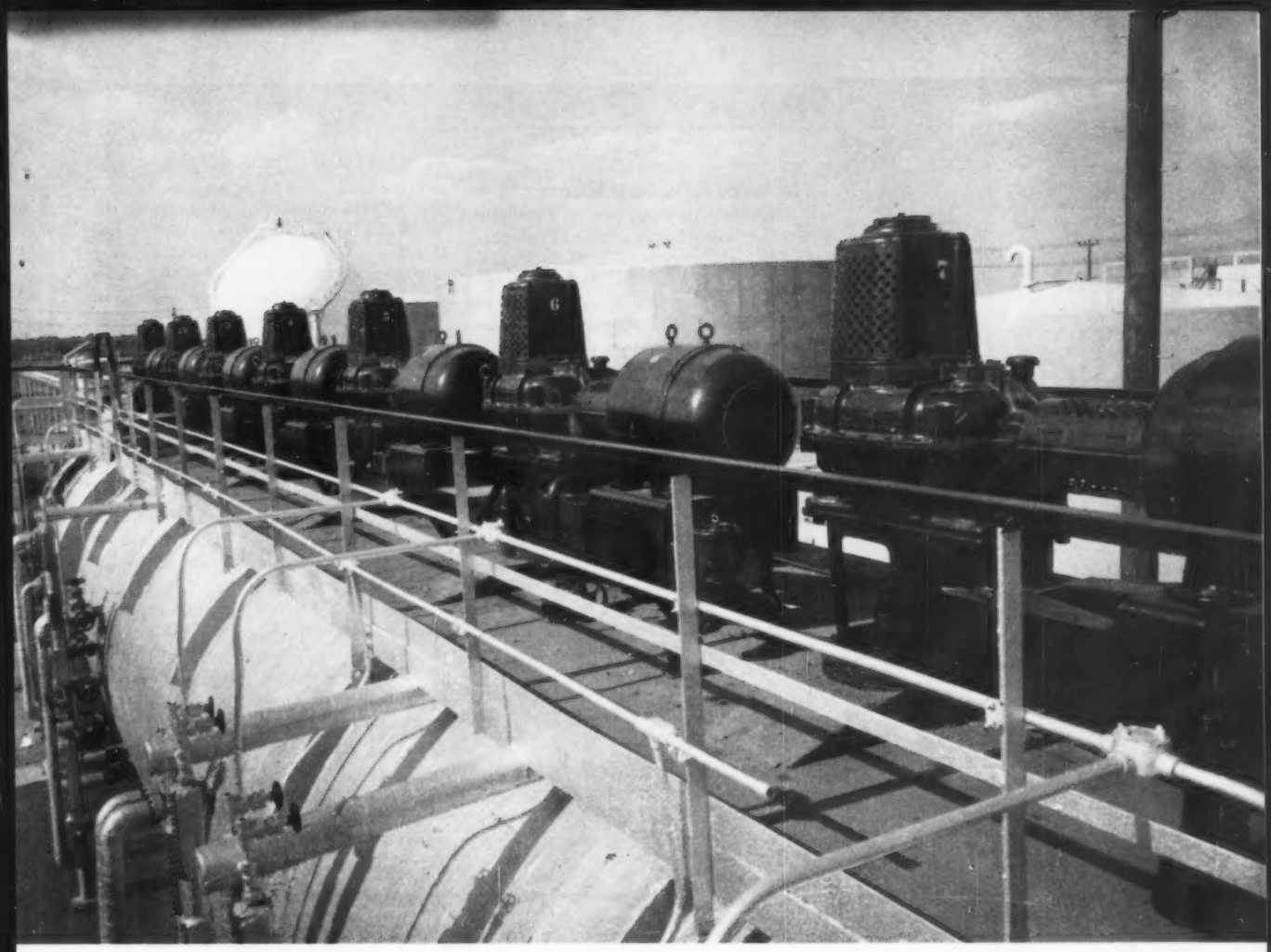
11. (a), (c), and (d). The Handbook section on treating (Page 233) includes complete descriptions of these processes.

12. True. Handbook section on polymerization includes other late developments in this type of process on Page 229.

13. True. The method of making such tables is what David H. Kannapell's article entitled "Foundation Sizing Simplified" on Page 290 is all about.

14. (a) and (e) are essential. (f) and (g) are usually in the plant standards book and the estimator already knows these answers. The check list of essential data for 22 other types of process equipment in "Check List for Better Estimates", Page 285, can assure you of transmitting sufficient data to estimating and getting a good estimate.

For more data on advertised products, use Readers' Service Cards, last page.



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Into one end of this big reactor flow refinery streams almost worthless as automotive fuels. Out the other end runs a river that's rich in high-octane alkylate.

Squatting atop the reactor are seven 50-hp LIGHTNIN Mixers. From each one, a turbine-equipped steel shaft reaches down to whip into an emulsion the isobutane feed, the recycle olefins, and the viscous sulfuric acid catalyst.

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To earn this acceptance, MIXCO engineers studied alkylation processes intensively; made detailed model tests of agitation flow patterns in simulated reactor systems; applied specialized knowledge of the correct loading of mixer impellers to operate under varying reactor conditions.

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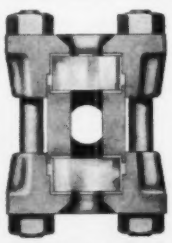
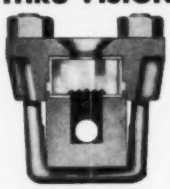


THRU VISION



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(Bair, W. G., Linden, H. R., Reid, J. M., *Natural Gas Supplements by Cyclic-Regenerative Hydrogasification of Oils*, Institute of Gas Technology, Technology Center, Chicago 16, Ill., 78 pages, $5).

Chemical Statistics

"Chemical Statistics Handbook," fifth edition, is a reference book relating to the chemicals and allied products industry for the years 1954-58. It is a continuation of the series begun in 1940 to fill the need for a single volume which would include all available chemical industry statistics from official sources. It retains the format of past issues and presents, in tabulated form, production and sales figures of thousands of chemical commodities. Sections of the book cover basic inorganics, tars, synthetic organics, coal-tar dyes, synthetic resins, synthetic rubber, industrial alcohol, fats and oils, naval stores, agricultural chemicals, metals, minerals and miscellaneous items.

Employment and wages, wholesale prices, import-export figures and corporate data are also covered. One section is devoted to Canadian chemical and mineral statistics.

(*Chemical Statistics Handbook*, fifth edition, Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N. W., Washington 9, D. C., 521 pages, $3.)

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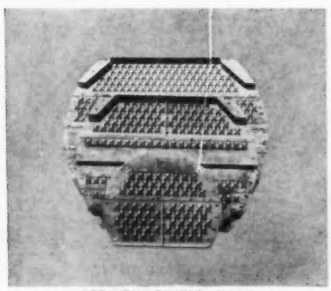

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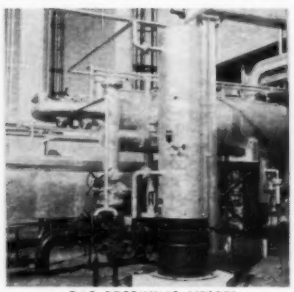
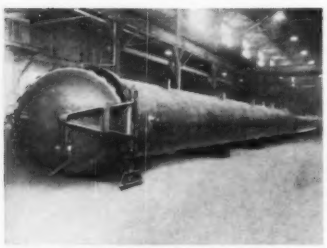


GAS RECEIVING VESSEL

A NUCLEAR SHIELDING VESSEL



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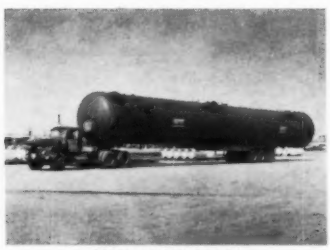

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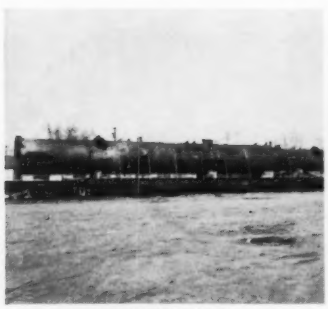

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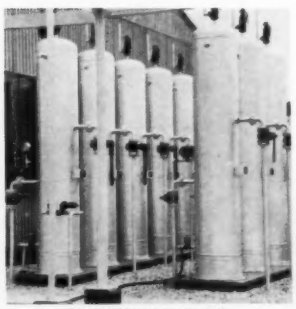

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tion, one on hydration-dehydration and one on cracking catalysts.

The first two volumes cover all the general approaches and tools used to gain a better understanding of both homogeneous and heterogeneous catalysis. Volume 3 summarizes existing knowledge on the subjects of hydrogenation and dehydrogenation, and Volume 4 is devoted entirely to the Fischer-Tropsch synthesis. Volume 5 includes hydrogenation, oxosynthesis, hydrocracking, hydrodesulfurization, hydrogen isotope exchange and related catalytic reactions. Volume 6 covers the area of hydrocarbon catalysis.

(Emmett, Paul H., *Catalysis Volume 7*, Reinhold Publishing Corp., For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, 378 pages, $13.50.)

Vessel and Piping Design

"Pressure Vessel and Piping Design" answers a demand as old as the ASME Boiler and Pressure Vessel Code, for it has never been possible to include in the codes enough complementary and background material to satisfy the needs of engineers working in this field. The society has gathered a wealth of important literature in this area of study.

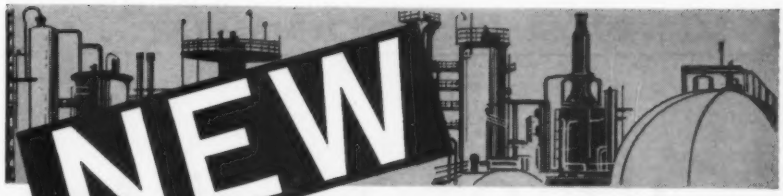
The book was made possible by the efforts of the editorial committee, composed of men who are outstanding in their field and long active on ASME projects, including the Boiler Codes. It contains ten sections, within each section the collected papers are arranged in chronological order of their publication.

(Pressure Vessel and Piping Design, The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., 710 pages, $10).

Motor Fuel Manual

"ASTM Manual for Rating Motor Fuels by Motor and Research Methods" provides the petroleum technologists with a new tentative method for determining the knock characteristics of motor fuel above 100 octane. In addition, other standards in the volume for rating motor fuels below 100 octane have been revised and brought up to date. Also included are two other methods: "Proposed Method of Test for Knock Characteristics of Motor Fuels Above 100 by the Motor Method" and "Proposed Method of Test for Motor and Research Octane Number of Small Samples."

(ASTM Manual for Rating Motor Fuels by Motor and Research Methods, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 196 pages, $6 for members, $7.50 for others).



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What's Happening...

U.S. Oil Outlook Appears Bright For Remainder of Year

Stable balancing between supply and demand improves national levels. More crude oil will be needed to meet 3.5 percent rise in 1960 demand

THE OIL INDUSTRY of the United States currently has an improved outlook, with hopes of better markets, prices and earnings in the latter half of 1960. The improvement stems from better balancing of supply with demand since the beginning of this year.

Previously, there were periods of overproduction of crude oil and natural gas liquids, and excessive imports of crude and products. Supply exceeded lagging demand. Prices of products sank to low and sometimes unprofitable levels. Crude oil prices have been gradually working lower since 1957.

The industry since 1957 has been troubled from both the demand and supply sides. Demand was adversely affected during the recession of 1958, improved in 1959, but again lagged somewhat in 1960. Relatively warm weather during the past December, January and February made the latest heating oil season generally lean for profits. Meanwhile, actual and potential supply have been so large as to keep markets disturbed and prices low.

Demand. Total demand for all oils in 1960 will average 9,998,000 barrels daily, an increase of 336,000 barrels or 3.5 percent over 1959. This is the recently revised forecast of the U. S. Bureau of Mines. It is somewhat short of the bureau's expectations at the beginning of the year.

Lagging of demand has been under way since 1957. In 1958, the total demand was down 3/10 of 1 percent. In 1959, it was up 3.2 percent. These results contrast with typical increases around 5 percent in eariler postwar years. And it has been difficult for the industry to adjust to the slower rates of growth of business volumes.

However, it may be that the industry will have to be content with slower growth henceforth. Working against faster growth are various factors, including increased competition from natural gas, slower sales of new motor vehicles, traffic congestion and wide use of small automobiles.

Expected increases in demand in 1960 include gains of 2.8 percent for gasoline, 6.9 percent for kerosine, 3.9 percent for distillate fuel oil, 2.1 percent for residual fuel oil and 5.2 percent for all other oils combined.

Supply. After adding unnecessarily to product stocks in 1959, the U. S. industry is expected to make some essential net withdrawals of products from storage in 1960. Assuming such withdrawals, the Bureau of Mines figured a need for new supply of 9,858,000 barrels daily in 1960, up only 145,000 barrels or 1.5 percent.

Total imports are expected to be about the same in 1960 as in 1959. And production of natural gas liquids is forecast at 921,000 barrels daily, up 42,000 barrels or 4.8 percent. This would leave a need for 7,158,000 barrels per day of crude oil production, up 104,000 barrels or 1.5 percent.

Demand for All Oils in the United States, by Quarters, Showing the Year 1959 and a Revised Forecast of 1960

(Thousand Barrels Daily . . . Source: U. S. Bureau of Mines)

DEMAND															
Total Demand	**10,643**	**10,801**	**1.5**	**9,019**	**9,313**	**3.3**	**9,017**	**9,390**	**4.1**	**9,989**	**10,490**	**5.0**	**9,662**	**9,998**	**3.5**
Gasoline	3,759	3,778	0.5	4,305	4,445	3.3	4,407	4,500	2.1	3,972	4,180	5.2	4,111	4,226	2.8
Kerosine	466	493	5.8	162	202	24.7	201	242	20.4	390	433	11.0	304	325	6.9
Distillate	2,670	2,738	2.5	1,372	1,405	2.4	1,216	1,260	3.6	2,129	2,260	6.2	1,843	1,915	3.9
Residual	2,088	2,014	— 3.5	1,433	1,452	1.3	1,241	1,361	9.7	1,656	1,720	3.9	1,603	1,637	2.1
All Others	1,660	1,778	7.1	1,747	1,809	3.5	1,952	2,027	3.8	1,842	1,897	3.0	1,801	1,895	5.2
Exports	**224**	**202**	**— 9.8**	**225**	**209**	**—7.1**	**201**	**200**	**—0.5**	**193**	**200**	**3.6**	**211**	**202**	**—4.3**
Crude Oil	7	9	28.6	7	7	.....	6	7	16.7	7	7	.....	7	7	.....
Products	217	193	—11.1	218	202	—7.3	195	193	—1.0	186	193	3.8	204	195	—4.4
Domestic Demand	**10,419**	**10,599**	**1.7**	**8,794**	**9,104**	**3.5**	**8,816**	**9,190**	**4.2**	**9,796**	**10,290**	**5.0**	**9,451**	**9,796**	**3.7**
Gasoline	3,719	3,744	0.7	4,251	4,400	3.5	4,363	4,450	2.0	3,929	4,135	5.2	4,066	4,183	2.9
Kerosine	464	490	5.6	161	200	24.2	198	240	21.2	385	430	11.7	301	340	13.0
Distillate	2,632	2,708	2.9	1,338	1,370	2.4	1,179	1,225	3.9	2,100	2,220	5.7	1,809	1,880	3.9
Residual	2,009	1,957	— 2.6	1,371	1,397	1.9	1,195	1,315	10.0	1,615	1,675	3.7	1,547	1,586	2.5
All Others	1,595	1,700	6.6	1,673	1,737	3.8	1,881	1,960	4.2	1,767	1,830	3.6	1,728	1,807	4.6
Runs to Stills	8,190	8,088	— 1.2	7,916	7,952	0.5	7,947	8,105	2.0	7,924	8,300	4.7	7,994	8,112	1.5

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Specify TAILORED TUBING!

Made by a specialty mill with 33 years' experience tailoring quality seamless steel tubing to meet the most rigid specifications!

PRESSURE TUBING

TAILORED TUBING for continuous service under high pressures and temperatures.

Specifications:

ASTM	Grade	Analysis
A-53		Carbon steel
A-106		Medium carbon steel
A-333	C	1022 steel
	3	2315
	5	2512
A-335	P1	Carbon, ½% Moly.
	P2	½% Chrome, ½% Moly.
	P3	1¼% Chrome, ¼% Moly.
	P3b	2% Chrome, ½% Moly.
	P5	5% Chrome, ½% Moly.
	P5c	5% Chrome, ½% Moly. with Titanium
	P7	7% Chrome, ½% Moly.
	P9	9% Chrome, 1% Moly.
	P11	1¼% Chrome, ½% Moly.
	P12	1% Chrome, ½% Moly.
	P21	3% Chrome, 1% Moly.
	P22	2¼% Chrome, 1% Moly.

Sizes: ⅛" to 3" O.D., including standard I.P.S. sizes ⅛", to 2½" inclusive.

Wall thicknesses in an extra wide range, including Schedules: 40, 80, 160 Cold Drawn, and Hot Finished, Seamless pipe.

MECHANICAL TUBING

Machining parts with a hole? Use TAILORED TUBING to simplify fabrication, save time and material.

Available in many shapes (square, hexagonal, etc.) with O.D. from 3/16" to 3½".

Carbon Steel: Standard A.I.S.I. from grade designation C-1008 to C-1070 inclusive.

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Resulphurized Steel: In grades C-1118, C-1137 and C-1141.

Can be furnished cold drawn, normalized or any special anneals. Our superior annealing equipment assures meeting specifications with absolute minimum decarburization.

OIL-COUNTRY TUBING

Highest quality TAILORED TUBING for maximum dependability and outstanding service.

Grades: J-55, N-80, P-105 and higher.

Sizes: All the macaroni sizes, ¾", 1", 1¼", 1½", and 2" I.P.S.

Lengths: All standard length Ranges.

Facilities to full length normalize and straighten.

AIRCRAFT TUBING

This sturdy TAILORED TUBING is supplied in round, oval, square, rectangular and other shapes to your specifications.

Specification	Analysis	
MIL-T-5066	1025	Steel
MIL-T-6732	8630	
MIL-T-6733	8735	
MIL-T-6735	4135	
MIL-T-6736	4130	
AMS-5050	1010	
AMS-5075	1025	
AMS-6360	4130	
AMS-6365	4135	
AMS-6530	8630	Magnaflux Quality Steel
AMS-6535	8735	
AMS-6274	8620	
AMS-6281	8630	
AMS-6282	8735	
AMS-6283	8735	
AMS-6323	8740	
AMS-6371	4130	
AMS-6372	4135	
AMS-6381	4140	
AMS-6415	4340	

DECARBURIZATION

With the most versatile annealing and heat treating equipment in use today, Michigan Seamless can supply cold worked, normalized, stress-relieved and soft-annealed tubing for any end use, with decarburization normally less than half allowed by standard specifications.

We will quote and guarantee material to special government specification number MIL-T-6736A insofar as depth of decarburization is concerned.

CONDENSER, HEAT EXCHANGER, AND BOILER TUBES

Now, for the first time plain or integral fin U-tubes from one source! Almost all grades of TAILORED TUBING below are also available as integral fin tube and all can be U-bent to your specifications. Bi-metal tubing also available.

ASTM	Grade	Analysis
A-83		Low carbon steel
A-106		Medium carbon steel
A-161		Low carbon steel
A-179		Low carbon steel*
A-192		Low carbon steel
A-210		Medium carbon steel
A-334	C	1022 Steel*
A-161	T1	Carbon, ½% Moly.
A-199	T3b	2% Chrome, ½% Moly.*
	T4	2½% Chrome, ½% Moly.*
	T5	5% Chrome, ½% Moly.*
	T7	7% Chrome, ½% Moly.
	T9	9% Chrome, 1% Moly.
	T11	1¼% Chrome, ½% Moly.*
	T21	3% Chrome, 1% Moly.
	T22	2¼% Chrome, 1% Moly.*
A-200	T3b	2% Chrome, ½% Moly.
	T4	2½% Chrome, ½% Moly.
	T5	5% Chrome, ½% Moly.
	T7	7% Chrome, ½% Moly.
	T9	9% Chrome, 1% Moly.
	T11	1¼% Chrome, ½% Moly.
	T21	3% Chrome, 1% Moly.
	T22	2¼% Chrome, 1% Moly.
A-209	T1	Carbon, ½% Moly.
	T1a	Carbon, ½% Moly.
	T1b	Carbon, ½% Moly.
A-213	T3b	2% Chrome, ½% Moly.*
	T5	5% Chrome, ½% Moly.*
	T5c	5% Chrome, ½% Moly. with Titanium
	T7	7% Chrome, ½% Moly.
	T9	9% Chrome, 1% Moly.
	T11	1¼% Chrome, ½% Moly.*
	T12	1% Chrome, ½% Moly.*
	T17	1% Chrome Vanadium
	T21	3% Chrome, 1% Moly.
	T22	2¼% Chrome, 1% Moly.*
A-334	3	2315 Steel*
	5	2512 Steel

*Integral fin tube available.

Sizes: 3/16" to 3" O. D., with wall thicknesses varying from very light to extra heavy. Integral fin tube available in ⅜" to 1" O. D. inclusive.

MICHIGAN SEAMLESS TUBE COMPANY

SOUTH LYON, MICHIGAN

A SUBSIDIARY:

GULF STATES TUBE CORPORATION

ROSENBERG, TEXAS

Send your job specifications to us. We will tailor the tubing to do your job. For more details write for full catalog.

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TAILORED TUBING

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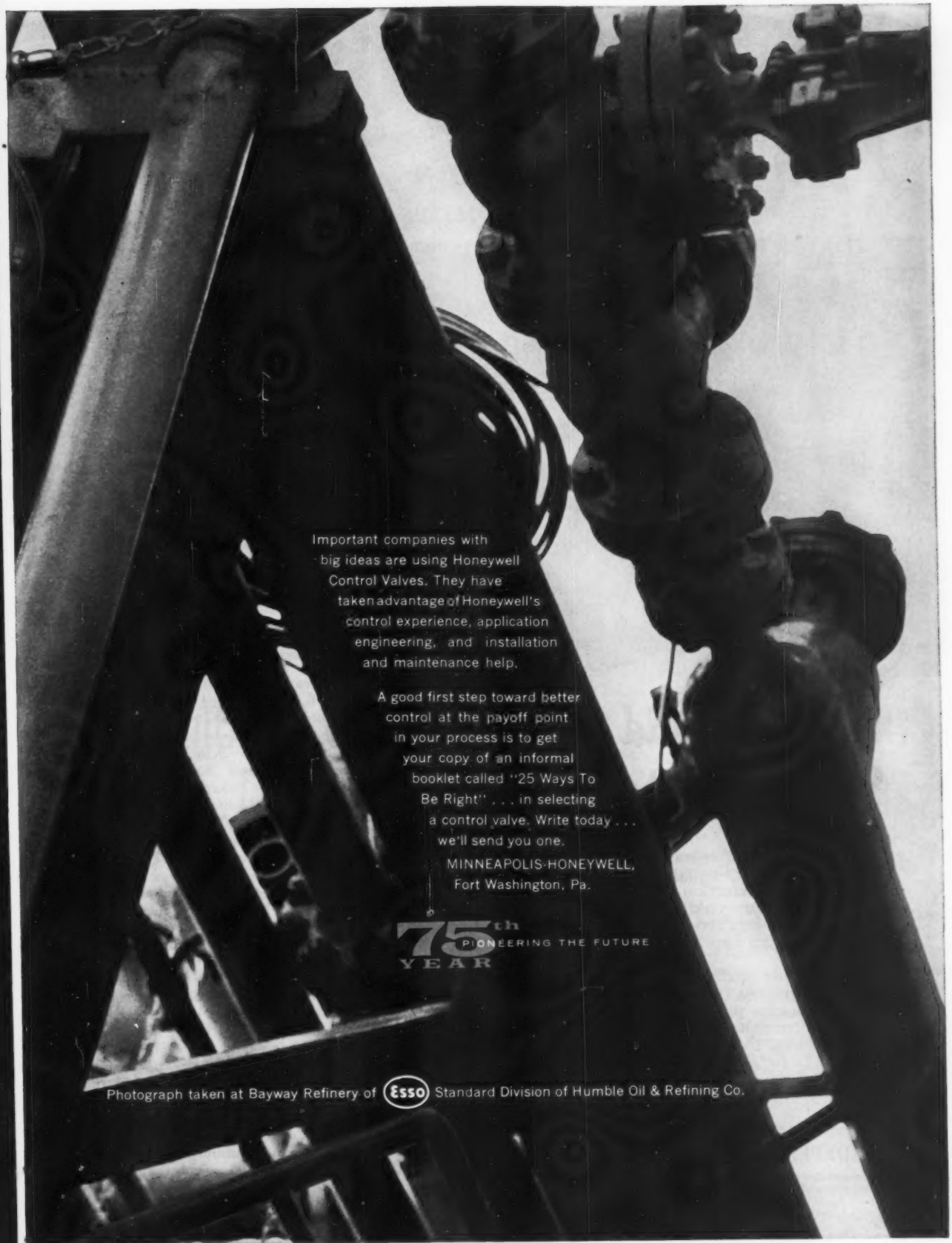
Michigan Seamless Tube Company

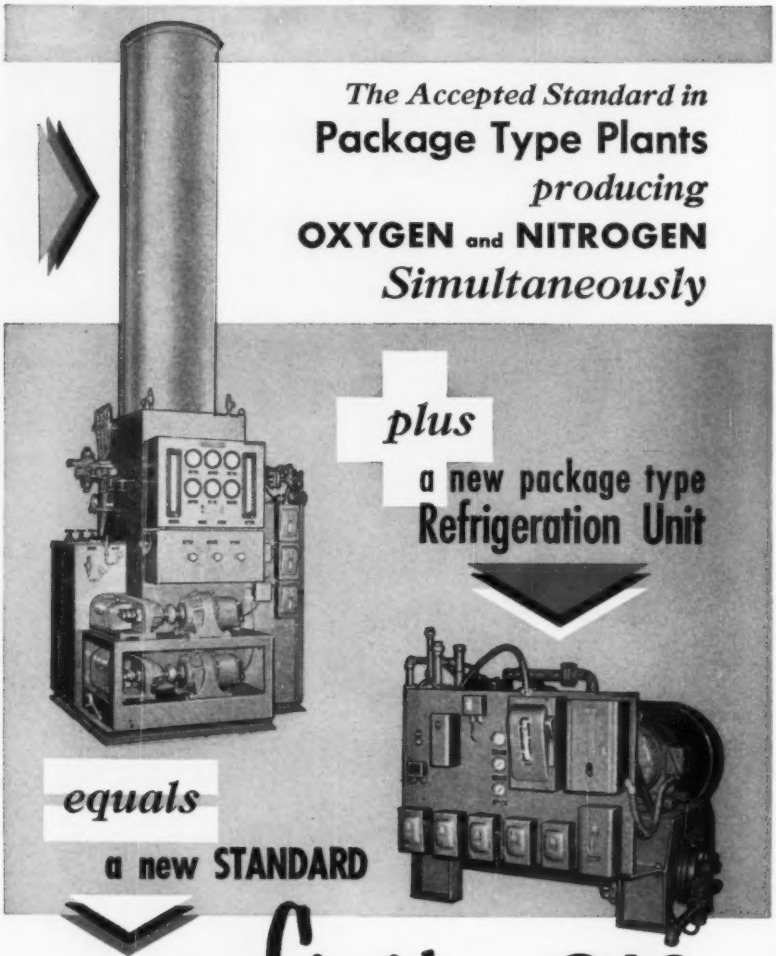
Gulf States Tube Corporation

Honeywell
First in Control
SINCE 1885


Important companies with big ideas are using Honeywell Control Valves. They have taken advantage of Honeywell's control experience, application engineering, and installation and maintenance help.
A good first step toward better control at the payoff point in your process is to get your copy of an informal booklet called "25 Ways To Be Right" . . . in selecting a control valve. Write today . . . we'll send you one.
MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.
75th YEAR
PIONEERING THE FUTURE
Photograph taken at Bayway Refinery of Esso Standard Division of Humble Oil & Refining Co.

For more data on advertised products, use Readers' Service Cards, last page.

The Accepted Standard in
Package Type Plants
producing
OXYGEN and NITROGEN
Simultaneously



plus
a new package type Refrigeration Unit
equals
a new STANDARD

now *Liquid* or GAS
OXYGEN and NITROGEN
simultaneously

FLEXIBILITY of operation, providing **ANY COMBINATION** of products, liquid or high pressure gas **PLUS** simultaneous production of **BOTH** oxygen and nitrogen delivers maximum yield of combined products at minimum cost of operation with little operator's attention. Packaged design requires minimum of installation cost and space.

This most modern and efficient design from Independent combines the best features of the earlier two-product package plants pioneered by Independent with the latest concepts of external refrigeration. Type illustrated in 1500 to 5500 cu. ft. per hour capacities. Other types in larger and smaller sizes. Pure argon available on larger sizes.

We invite your Inquiry

INDEPENDENT ENGINEERING COMPANY, Inc.
Manufacturers of
CONSULTING IECO DESIGNING RESEARCH
CYLINDERS AND GAS PRODUCING EQUIPMENT
ACETYLENE · OXYGEN · NITROGEN · ARGON
O'FALLON 6, ILLINOIS

Happenings . . .

Gulf Italia Withdraws Suit Against Communist Paper

Legal action has been withdrawn by Gulf Italia Co., a Gulf Oil Corp. subsidiary in Italy against L'Unita, Communist-slanted newspaper published in Italy, following the newspaper's complete retraction of a 1959 story which charged Gulf with "theft." The alleged "theft" referred to a 4 billion lire profit noted in Gulf Italia's 1957 annual report. This was considered a "theft," charged the Communist daily paper, because Gulf had discovered the Ragusa oil field in 1953 utilizing studies and exploratory data taken away from Italian government offices.

Gulf Italia subsequently filed a libel suit against the editor of L'Unita and the writer of the article and produced two suitcases filled with documentary evidence. This evidence proved that the statement by the newspaper was groundless, according to Gulf Italia's vice president, Nicolo Pignatelli Aragona, and that the discovery of the Ragusa oil field was based solely on four years of studies and exploratory activities carried out by Gulf.

Editors, Educators Set Up Technical Writing Institute

A new national organization, the American Industrial Writing Institute, has been established to improve the quality of business and technical communications. The new group has resulted from the merger of the Technical Writing Improvement Society, a national organization of educators, trade journal and industrial editors, and engineering management people, and the Western Technical Writing Institute, a West Coast technical writing school.

The new organization was formed to meet the need for a central clearing house and information center on industrial communications improvement. Studies have shown that communications are the major part of industrial and scientific overhead and that advances in the area of communications have not progressed with scientific and technical developments.

AIWI will publish a bimonthly writing improvement bulletin for management and quarterly newsletters for engineering and science writers. It is intended that the material issued to industrial firms and scientific organizations will form a continuing course of instruction for technical people. Individual membership in the new institute will be by invitation. Company subscribing membership will be available. The new organization will take over writing improvement research pro-

For more data on advertised products, use Readers' Service Cards, last page.

After 3 years of service, feather valves and other moving parts in air compressors show no trace of deposits or residue—still do not need cleaning.

"Cellulubes eliminate fires and explosions ... keep compressor parts clean"

says MR. T. E. DANIEL, Foreman, Cypress Compressor Station
Trunkline Gas Company, Cypress, Texas

"Since using Cellulube 220 in our air compressors we have never experienced or had any indication of fire or explosion in our compressed air systems," continues Mr. Daniel.

Installed at Trunkline's Cypress Compressor Station when it opened three years ago, Cellulubes thus provide an authoritative 7800-hour operating record that indicates not only efficient and far safer operation, but substantial savings as well. Mr. R. C. Carter, Trunkline's Compressor Department Superintendent, describes them thus:

"First and most important, of course, is the elimination of any risk to our personnel—from fire, explosion, or fragmentation. Secondly, we save on heavy equipment replacement costs, and thirdly, down-time losses.

"A major savings is in preventive maintenance. Formerly, we completely disassembled and cleaned air compressors every six months. Cellulubes keep machinery so clean that this interval has been indefinitely extended, and so far we've saved at least 60 man-hours. Finally, Cellulubes never get 'dirty,' nor do they burn away by friction or compression."

Cellulubes . . . the *safe* lubricants and hydraulic fluids . . . are available in six controlled viscosities. If you'd like a sample for evaluation, please let us know the application involved.
Celanese Chemical Company, a Division of Celanese Corporation of America, Dept. 574-S, 180 Madison Ave., N.Y. 16.

Celanese® Cellulube®

Cellulubes... fire-resistant functional fluids

Canadian Affiliate: Canadian Chemical Co., Limited, Montreal, Toronto and Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N.Y.

OIL KING!

Acknowledged so

by oil men who have used all kinds of gauges

The ten-gallon hat on the Marsh Mastergauge is worn as a crown of acceptance, an emblem of excellence... well earned through years of rugged oil country service.

Just as kings ascend thrones through lineage, the Mastergauge was destined for "royal" acclaim the day it hit the drafting board. Because every product born at Marsh is "born to the purple."

For what other gauge has the Marsh heritage of functional design innovations? Only Marsh offers Conoweld construction, the Marshalloy case, "coined" sector Mastergauge movement, "Recalibrator" adjustment, and optional Safecase protection plus.

That's why we say the *next* great thing that happens in gauges will happen at Marsh.

MARSH INSTRUMENT COMPANY, Dept. R, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

In stock at your nearest Supply House

"THE STANDARD OF ACCURACY"

jects started by TWIS and WTWI. Temporary quarters of the new organization are in Pasadena, Calif. A $75,000 national headquarters building and library is planned.

Air Force Fuel Consumption Higher Than In War-time

5.9 billion gallons of aviation fuels were consumed by the U.S. Air Force during fiscal year 1960. This was 8.5 percent more by volume than the 5.4 billion gallons required in 1945, the peak year of World War II. Col. Wilson A. Chapman, head of the Air Force directorate of petroleum and chemicals, noted that although the number of plane-hours flown annually by the Air Force is now only a fraction as great as during the war, the greater fuel requirements for present day jet operations more than makes up the difference.

Jet fuel today represents more than 62 percent of the Air Force's total requirements for air and ground supplies, and 77 percent of the aviation fuel consumed, Col. Chapman said. During World War II, extensive use of heavy bombers caused the overall average to climb sharply from 44.2 gallons per plane-hour in 1941 to 129.8 gallons by 1945. With the ever-growing military emphasis on jets that has come about since 1946, however, the fuel average for all Air Force planes climbed from 210.2 to 232.4 gallons per plane-hour during the Korean period, and has since zoomed to something over a 700-gallon hourly average today, according to Col. Chapman.

Crude Oversupply Causes Layoffs At Gulf Plant

A reduction of the work force by 625 employes has begun at Gulf Oil Corp's Philadelphia refiinery, according to an announcement by T. A. Dietz, refinery general manager. To minimize the number of people to be laid off, early retirement is being offered to eligible employes. The action was described by Gulf officials as an operating adjustment made mandatory by serious conditions of oversupply of both crude oil and products on a national and world-wide scale.

For the past several years stocks of crude oil and of most petroleum products have gradually mounted to proportions that threaten the stability of the industry, and the pressure of these stocks to find markets has led to a steady weakening of prices.

Gulf's Philadelphia refinery, one of the

SWECO process equipment...

Three Ways More Dependable

Seasoned Engineering Staff
SWECO engineers are constantly meeting petroleum industry challenges of new extremes in temperature and pressure. They develop improved equipment designs and methods to obtain the highest thermal and mechanical efficiency for economical, long-range operation.

Specialized Production Facilities
Construction of heat exchangers, pressure vessels, steam jet ejectors and other process equipment requires special production skills, equipment and experience. SWECO's 40 years of fabrication experience, much of it with special metals and alloys, results in high quality standards and reasonable production costs. Continuous quality control is maintained throughout production with all SWECO equipment thoroughly tested before shipment.

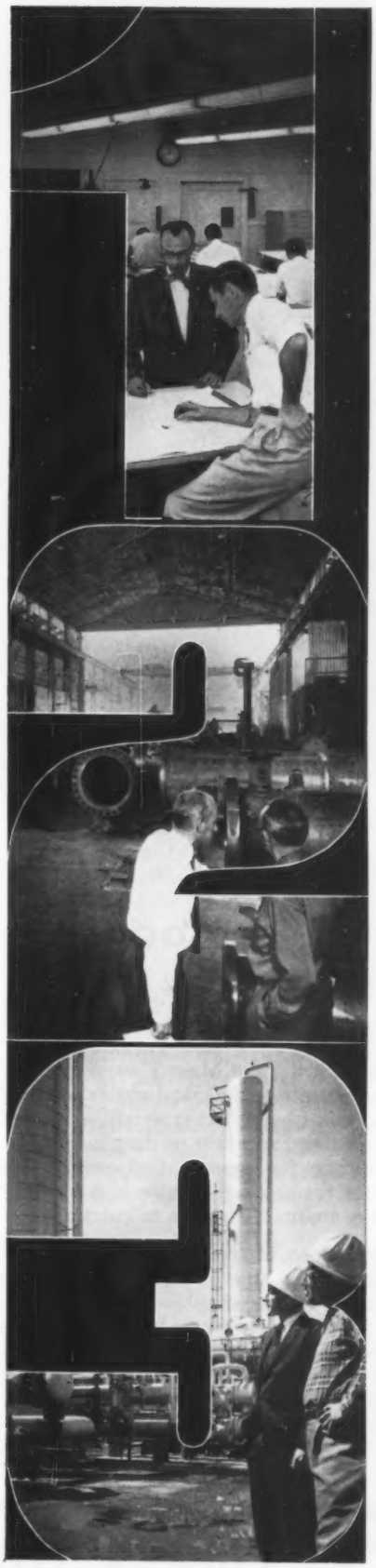
"One-Man" Project Responsibility
A *single* SWECO Sales Engineer serves as your project co-ordinator and expediter. He communicates your equipment requirements to engineering and works closely with production to assure that your specifications and delivery dates will be met. Because he *knows* your unit, he gives you straight answers and immediate service.

Southwestern Engineering Company

SWECO

4800 Santa Fe Ave., Los Angeles 58
Engineers—Constructors—Manufacturers

For illustrated literature on SWECO heat exchangers, pressure vessels, steam jet ejectors and other process equipment, write for your copy of Bulletin 14-333.



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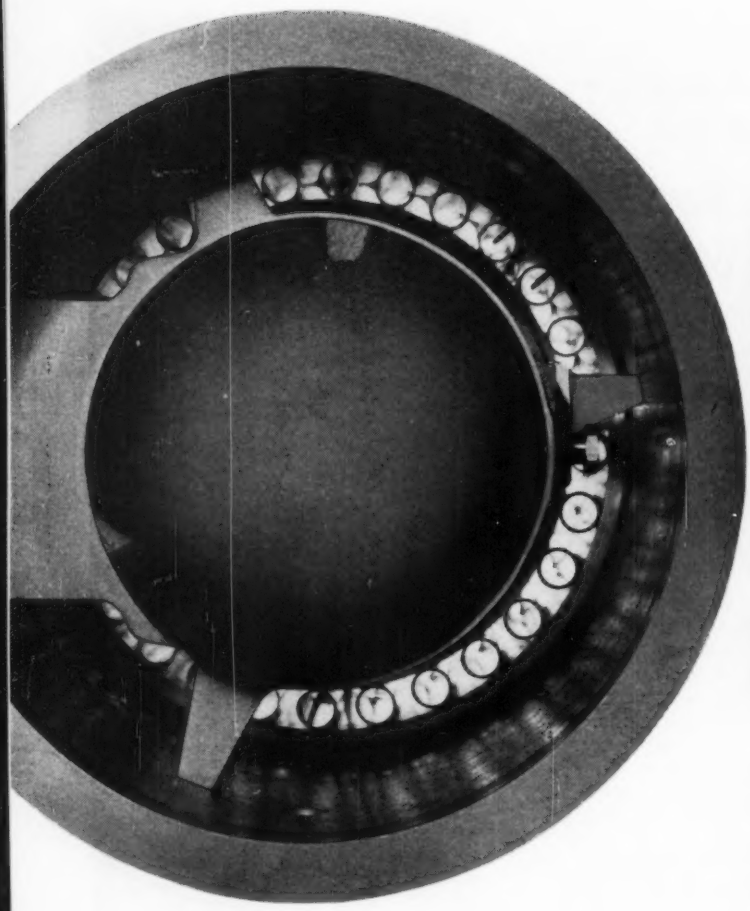


ACCURATE METERING DIRECT IN POUNDS!

In the measurement of Ethylene, liquid and gaseous; Propylene, liquid and gaseous; Methane; Natural Gas; Nitrogen; Freon, liquid and gaseous; Oxygen; Helium; Kerosene; Propane; Butane; Naphtha; Carbon Dioxide, liquid and gaseous.

"ARE YOU GOING TO DETERMINE VOLUME? OR WEIGHT? WHICH IS THE MORE TANGIBLE?"

The BS&B True Mass Flowmeter satisfies the long-felt need for an accurate, economical meter which measures industrial liquids and gases by metering weight—not volume. It gives you a direct, immediate, accurate reading in pounds. No correction factors are necessary for pressure, temperature, super-compressibility, or any other variable which affects conventional metering devices. And there are no in-between calculations.

Fluid flows into one end of the meter and out of the other. Between inlet and outlet are the sensory and registering instruments. It's as simple—and complex—as that. The complexity is in the meter—not in the assumptions you must make, the recordings you must have, the calculations you must perform to get a delayed reading of uncertain accuracy. Which makes more sense? Determining volume? Or weight? Like to know more? Write immediately for all the facts.

BS&B mass flowmeter

WRITE FOR ILLUSTRATED BROCHURE

BLACK, SIVALLS & BRYSON, INC.

MASS FLOWMETER SALES

P.O. Box 1714 Dept. 3-F9

Oklahoma City, Oklahoma

largest on the East Coast, has a throughput capacity of 183,000 bpd. For some time the refinery has been operating well below capacity and under the new cutback throughput will be further reduced to 120,000 bpd.

Eight U. S. Oil Executives Tour Russian Operations

Executives from eight U.S. oil companies left on a tour of Russian oil operations and installations last month under an exchange program sponsored by the U.S. State Department. The trip to Russia and the exchange trip to the United States later this year by a Russian group were arranged by the American Petroleum Institute. W. W. Keeler, executive vice president of Phillips Petroleum Co. was the leader of the U.S. group.

Besides Keeler, the U.S. tourists to Russia included George S. Dunham, director of Socony Mobil Oil Co.; Ira H. Cram, senior vice president, Continental Oil Co.; W. M. Elias, vice president, Pan American Petroleum Co.; George T. Piercy, head of the Petroleum Economics Department, Standard Oil Co. (New Jersey); George F. Getty II, president, Tidewater Oil Co.; Neal J. Smith, vice president, Chevron Oil Co.; and Dr. Noyes D. Smith, Jr., vice president, Shell Development Co.

No Payments Made By Syria For Crude

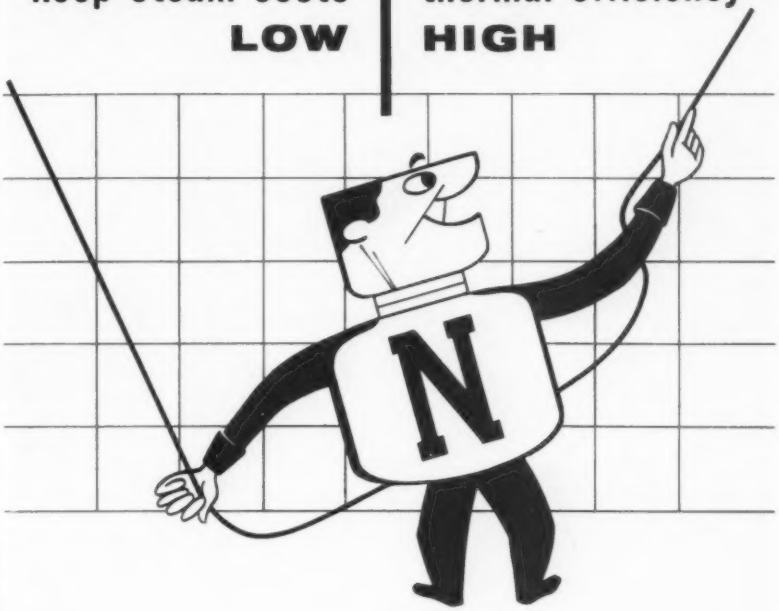
No current payment has been made by Syria for deliveries of crude to the Homs government refinery. The deliveries were made by Iraq Petroleum Co. on Trans-Arabian Pipe Line Co.'s account to the refinery. No payments have been sent by Syria to Iraq Petroleum or Trans-Arabian Pipe Line for the crude since the Homs refinery went on stream a year ago, because of a shortage of foreign exchange. Iraq Petroleum, however, has a debit balance with Syria.

Sunray Establishes New Chemical Subsidiary

A chemical and petrochemical research, manufacturing, and sales company will be organized as a wholly-owned subsidiary for Sunray Mid-Continent Oil

Nicholson Thermostatic Steam Traps

keep steam costs LOW | thermal efficiency HIGH



Low costs and high efficiency! Nicholson Traps give you both . . . by *design*. And here's how. Hardened stainless steel seats and valves are accurately lapped for sure, tight shut-off . . . so, there is no waste of live steam. True balanced pressure . . . the operating principle of these valves . . . assures fast intermittent discharge of condensate and air, resulting in maximum thermal value from every pound of steam produced.

As for capacity, these traps *really* have it . . . up to six times greater than ordinary traps. Maintenance? Practically none, for there is only one moving part. No links no pins. No pivots or levers. No adjustable orifices to stick or clog.

Sure, some traps cost less than Nicholson . . . but the 'savings' exist only on the invoice. In actual use, some other traps can cost you three or four times their price in annual steam waste. Be sure to weigh cost against value when *you* buy steam traps. Specify Nicholson Thermostatic Steam Traps on your lines and equipment.

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Offices in principal cities

Send for Catalog

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Please send a copy of Catalog #400
NAME _____
COMPANY _____
STREET _____
CITY _____ STATE _____

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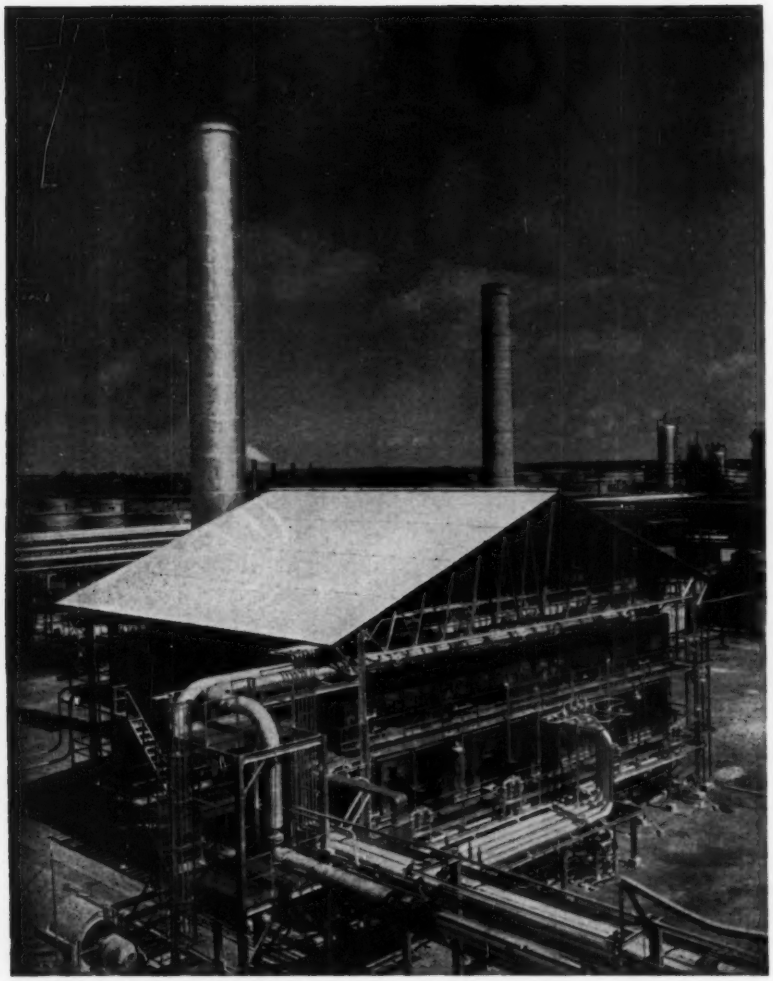
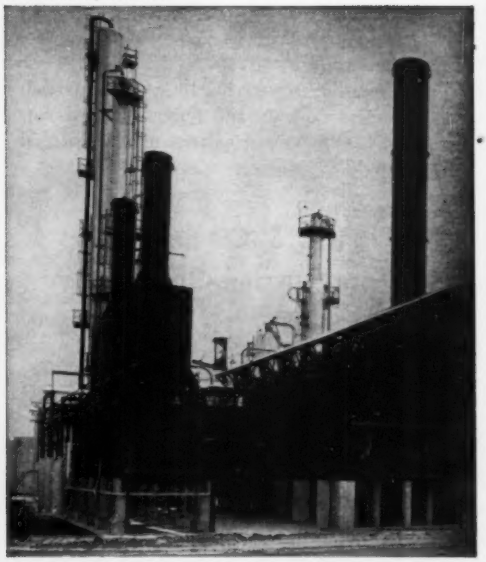
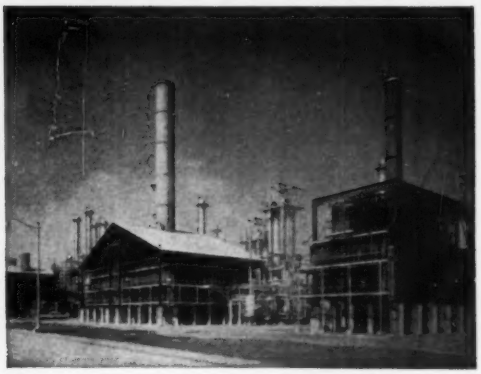


Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.





Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

HIGHER EFFICIENCY, LUMMUS OIL HEATERS

Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world

Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right*

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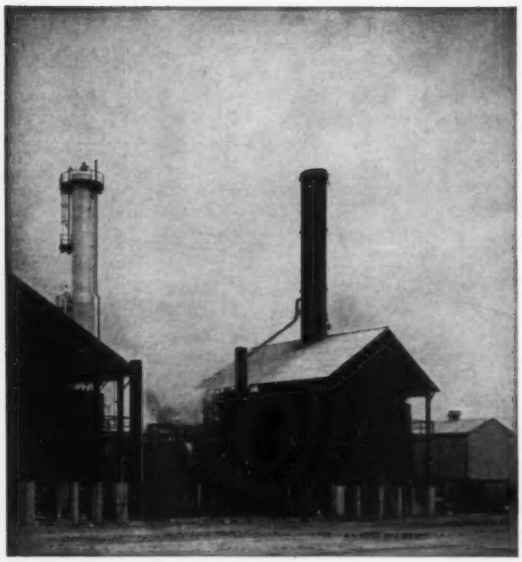
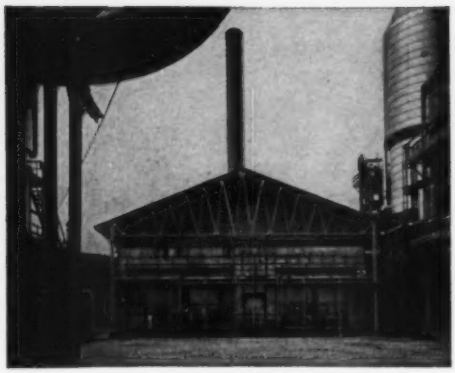
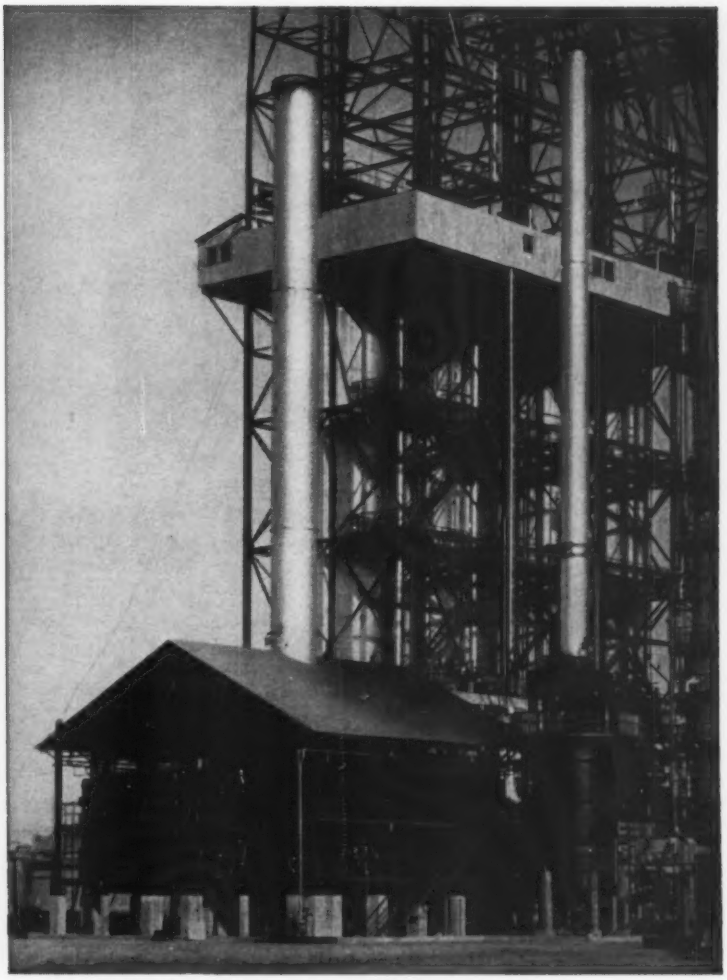




Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater – large or small.

LUMMUS

THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N. Y.

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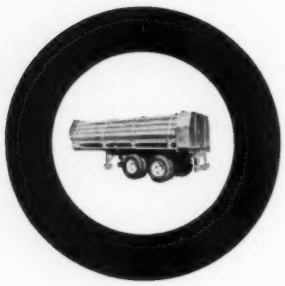
PIN

POINT

YOUR

GAS

TRANSPORTATION



WITH

TAYLOR-WHARTON

MOBILE

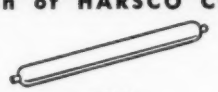
GAS STORAGE

More than a Century in Harrisburg 2, Pa.

H HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

CYLINDERS



TUBES

FLANGES

COUPLINGS

Happenings . . .

Co. with headquarters in Tulsa. "Sunray has growing plans," R. W. McDowell, Sunray chairman of the board of directors, said, "and our three refineries and numerous field gas and gasoline extraction plants put us in an excellent position to capitalize on the universal need for petrochemical products which are in high demand throughout the manufacturing industry."

McDowell stated that no limits for activity and aggressive entry into all phases of the petrochemical business were being placed on Sunray Chemical by the Sunray directors. "It is important," he said, "for the industry generally to locate new areas for the manufacture and sales of raw and finished products made from petroleum hydrocarbons. The company hopes to build or acquire additional facilities to produce polyethylenes, polypropylenes and naphthalenes.

Large Attendance Expected At CNGA Annual Meeting

A thousand members of the natural gasoline industry are expected to attend the 35th annual meeting of the California Natural Gasoline Association, October 13 and 14 at the Miramer Hotel, Santa Monica, Calif. The program will feature panel and forum discussions geared to present-day operations and papers slated toward the anticipated conditions of the future.

Topics to be covered are:

- Piston Rings—Their Place in Gas Engine Operations.
- Automation for the Operator.
- The Intrinsic Concept of Piston Compression.
- The Helium Activity of the Bureau of Mines, U.S. Department of Interior.
- Control of Propane Vapor Pressure by Closed-Loop Chromatography.
- From Six Plants to Three.
- New Engines from Old.
- Methods for Increasing Capacity of Existing Plants.
- More Operating Instruments—Fewer Operating Employes.
- Application of Computers to Process.
- Iso-Cracking.
- Unifining.

IRAA Continues Restraint Campaign

It is imperative that the oil industry reappraise the statistical situation and that it take action immediately if it is to avoid retrogression, reports the Independent Refineries Association of America. Until mid-June, according to

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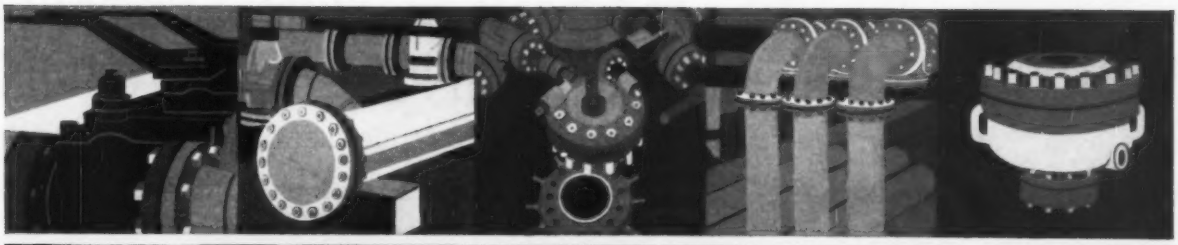
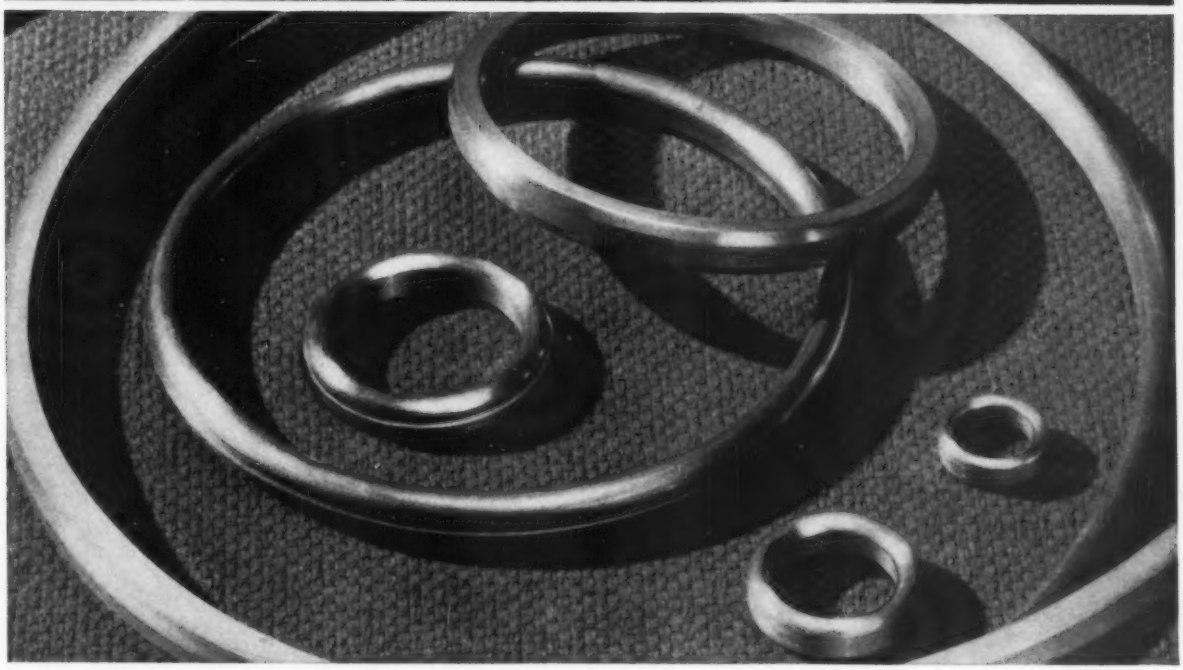




Get safer, surer sealing in ring-grooved joints with J-M V-TITE® GASKETS

YOU WILL BENEFIT BY CHOOSING THE GASKET PROVED IN SO MANY APPLICATIONS!

If you are concerned with the design or maintenance of ring-type joints, it will pay you to insist on the tighter, more efficient and longer-lasting seal you get with J-M's V-Tite design. Many equipment builders install these outstanding gaskets, and if it's your job to keep this equipment operating at top efficiency, here's a good point to remember: the gaskets that are right to *start* with . . . are right to *stay* with.

V-Tite Gaskets are "right" because every step in their manufacture is meticulously performed. Close tolerances are rigidly maintained for matching of rings with flange grooves. Carefully-controlled annealing keeps gasket hardness well below flange hardness . . . to assure proper flow and sealing without damaging the flange surfaces. Contact surfaces are smoothly finished . . . with no ridges, no tool or chatter marks that cause joint leakage.

J-M produces a wide selection of custom-designed and standard gaskets in any material, dimension or cross-section you require . . . including the new pressure-actuated BX Ring Gasket for extreme pressure service up to 15,000 psi at temperatures up to 250 F.

Complete information from your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

V-Tite Gaskets meet API specifications

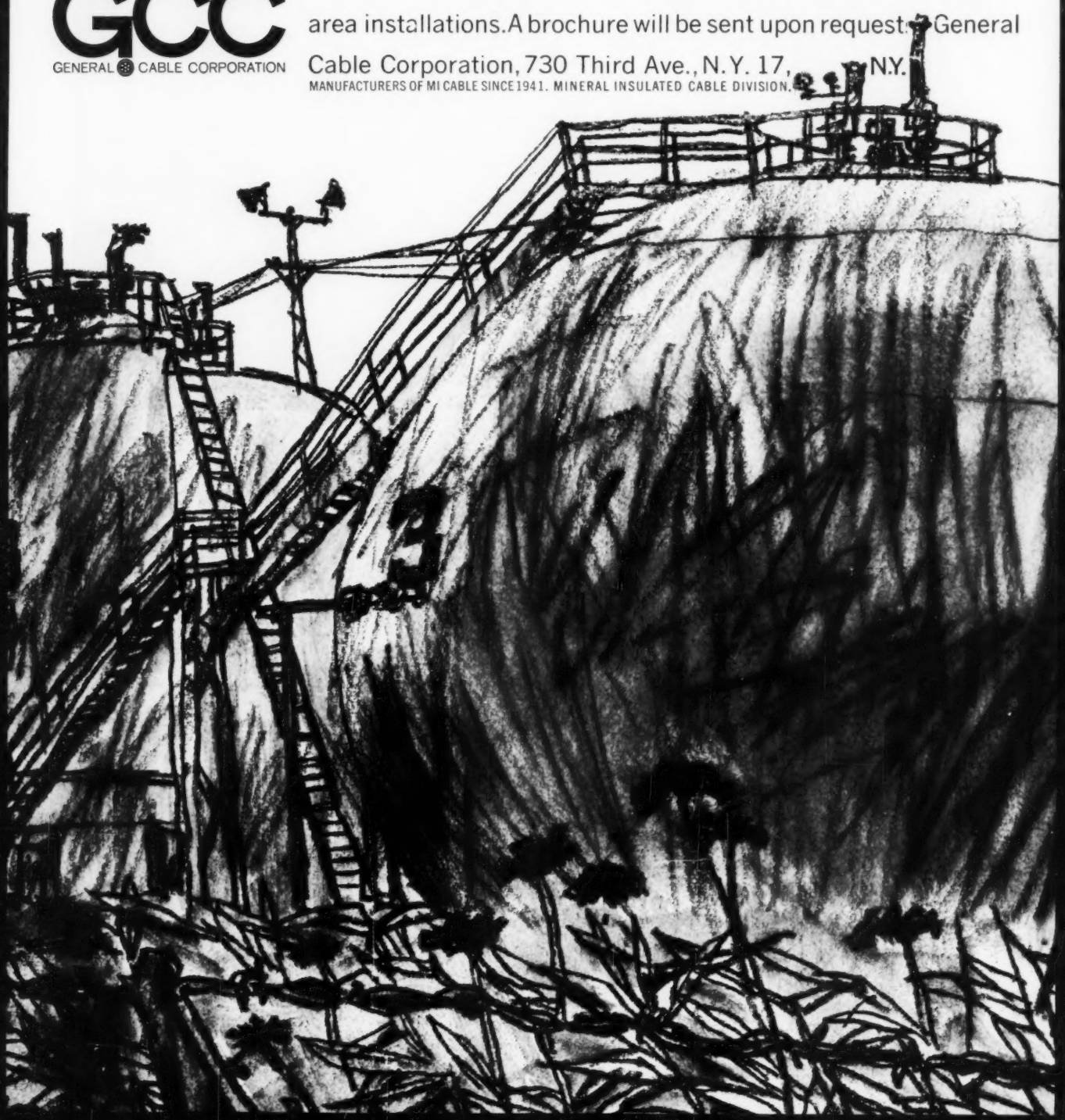
For more data on advertised products, use Readers' Service Cards, last page.

ONLY MI OFFERS SO MUCH FOR SO MANY HYDROCARBON PROCESSING APPLICATIONS

In process areas, catalytic reformers, cracking units, crude distillation areas . . . wherever gases and oils under pressure are a constant hazard . . . a Mineral Insulated wiring system ensures complete safety with service. One important reason . . . it's fireproof, with no vapor passage throughout the cable run. Investigate the many other built-in qualities that make Mineral Insulated the cable for hazardous area installations. A brochure will be sent upon request. General Cable Corporation, 730 Third Ave., N.Y. 17, N.Y.

GCC
GENERAL CABLE CORPORATION

MANUFACTURERS OF MI CABLE SINCE 1941. MINERAL INSULATED CABLE DIVISION.



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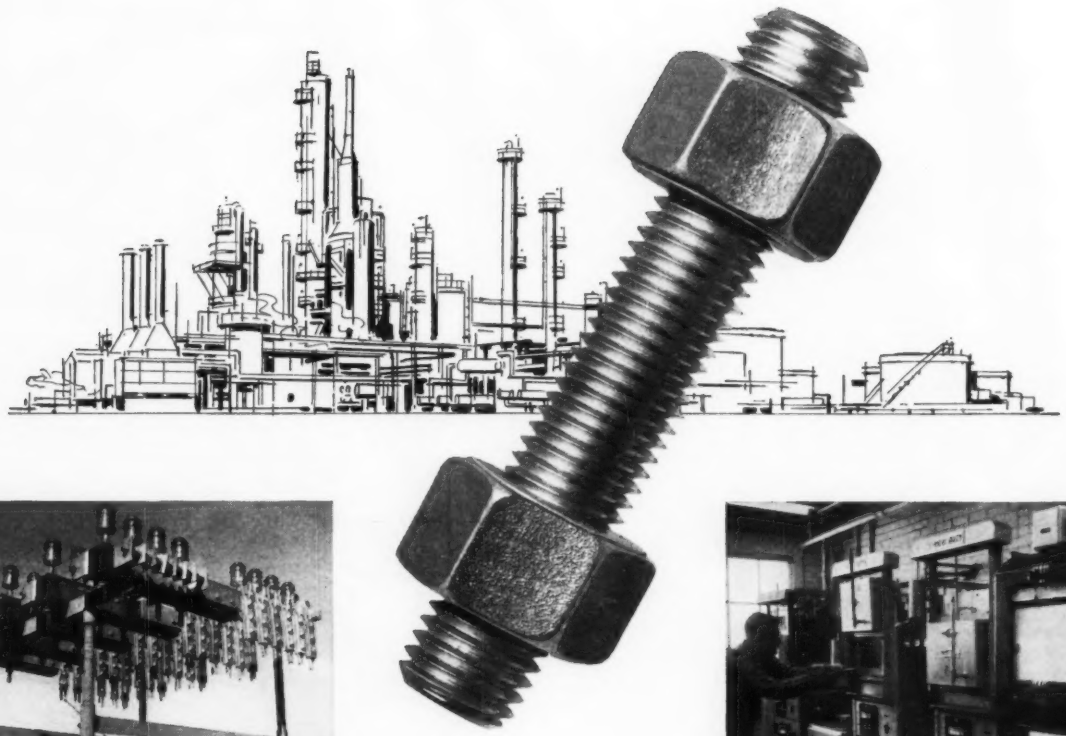
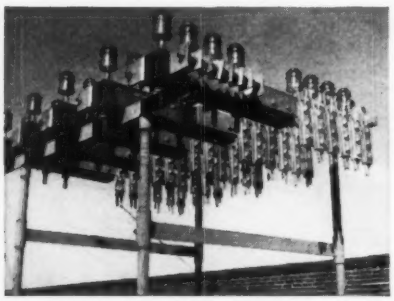
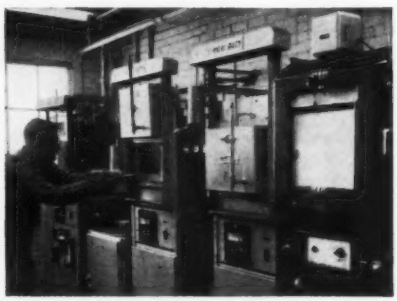




In Refinery Atmospheres—*A two-year test conducted in the severe industrial atmosphere of an oil refinery proved the superior corrosion-resistance of Bethalume over competitive coatings. The competitive items lost their protective coatings at an average of 1.15 mils/yr. The Bethalume-coated products lost at an average rate of 0.05 mils/yr.*



At Elevated Temperatures—*Tests, exposing uncoated and aluminum-coated C1020 steel (1000 hours—1200 deg F), showed a 26.3 pct weight loss in the uncoated steel, but no weight loss in the aluminum-coated sample; proving Bethalume-coated studs and nuts well suited for oil refinery high-temperature connections.*

These test results confirm long service life of Bethalume coating for quenched nuts and alloy studs

The test findings are good, practical reasons why you get more dependable, and longer service life from Bethalume-coated quenched nuts and continuous-thread alloy studs.

Bethalume coating offers these other advantages—

1. Double-layer protection consisting of a pure aluminum coating on top of a metallurgically bonded, iron-aluminum alloy.
2. Uniform coating and clean, sharp bolt threads.
3. Prevention of galling.
4. Oil refinery tests proved that aluminum coating withstands hydrogen sulfide better than any competitive coating, especially at high temperatures.

It all adds up to this: the Bethalume coating offers low-cost bolting for your high-temperature installations. The details may be obtained from your nearest Bethlehem office.

Steel

For strength
. . . economy
. . . versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Bureau of Mines figures, crude runs to stills reflected seasoned restraint and moderate cut-backs as compared with the first six months of 1959. This, coupled with moderate increases in demand for petroleum products, was effectively bringing inventories down to appropriate levels, IRAA said.

In the past few weeks there has been a sharp reversal. In the week ended July 8 the crude runs to stills sharply increased by more than 450,000 bpd. Gasoline inventories, instead of showing the seasonal decline essential to sound business, have stayed high and threaten to increase contro-seasonally, according to IRAA.

Synthetic Rubber Institute Formed

Synthetic rubber industry growth on a world-wide basis has brought about the formation of the International Institute of Synthetic Rubber Producers. The institute was organized by 15 synthetic rubber producers. Its purpose is to provide an effective means of promoting international trade of synthetic rubber.

In 1959 the combined production of synthetic rubber from all countries totaled 1,640,000 long tons as compared with the 440,331 long tons produced in 1949. Membership in the institute is open to any interested and qualified manufacturer of synthetic rubber. The membership will be subdivided into sections because industry needs may exist in certain geographical areas which are not common to manufacturers in all parts of the world. Initially there will be European and North American sections.

Cal Research Tests Effect of 'Rumble Strip'

A rock and plastic "rumble strip" system that sends sound and vibration warnings through an automobile's frame as it passes over patches of the material placed ahead of the danger spots is being tested by the Contra Costa County, California, Public Works Department and California Research Corp., a subsidiary of Standard Oil Co. (California). The tests are an attempt to find out whether motorists will slow down for hard-to-see traffic hazards if they get such a noise signal.

R. J. Schmidt, California Research paving research supervisor, said, "The idea of surface warning devices is not altogether new. It's been tried before ex-

BONDSTRAND®

An imaginative solution to your piping problems

From Missile Research...
A new product for process piping

- Twice as strong as steel
- 1/4 the weight of steel
- Inherently resistant to chemicals which attack stainless steel

Bondstrand is a corrosion-resistant, high strength, rigid pipe made of glass filaments bonded in chemically inert synthetic resins. It is capable of withstanding high pressure and the corrosive attack of many salt, acid, and alkaline solutions. The outside surface is equally resistant because the pipe is made entirely of corrosion-proof materials. No painting or maintenance is necessary.

Bondstrand's light weight and ease of assembly can save up to 50% of installation costs. Actual cost records of typical applications prove that the total installed cost averaged only 1.3 times that of carbon steel pipe. By eliminating the corrosion problem and down time for replacement or repair, Bondstrand saves many times its slightly higher initial cost.

Bondstrand is now available in sizes from 2" through 8" with all necessary couplings and fittings. Larger sizes available on special order.

Write for bulletin containing complete data, including physical properties, chemical resistance, flow rates, and other design information.

Amercoat® CORPORATION 126

A Subsidiary of American Pipe and Construction Co.

Dept. VI, 4809 Firestone Blvd., South Gate, California

921 Pitner Ave. Evanston, Ill. | 360 Carnegie Ave. Kenilworth, N. J. | 111 Colgate Buffalo, N.Y. | 2404 Dennis St. Jacksonville, Fla. | 6530 Supply Row Houston, Tex.

For more data on advertised products, use Readers' Service Cards, last page.

See why ALCOA ALUMINUM makes a good design habit

Requirement: Simple, low-cost heated lines to pipe high viscosity fluids
Key to Good Design: Specify UNITRACE and DUOTRACE, Alcoa's extruded aluminum pipes with integral steam chambers

With the development of UNITRACE® Piping, ALCOA created an entirely new technique for piping viscous fluids. Trace and product chamber are extruded in a single unit of light, strong, corrosion-resistant ALCOA® Aluminum. This integral steam-traced pipe eliminates the need for cumbersome, costly, inefficient pairing of separate pipes for steam and product. The resultant savings in initial cost are coupled with a major increase in the efficiency of heat application to the product piped.

Subsequent development of special flanges, elbows, adapter flanges and UNITRACE Trace Caps has made it possible to design and install completely integrated UNITRACE piping systems . . . compatible with standard piping components.

Now ALCOA has developed a new product, DUOTRACE,* to expand the design range of integrally traced piping systems. DUOTRACE contains not one but *two* trace chambers plus a product chamber in a single extruded aluminum pipe. This makes DUOTRACE the perfect solution to the need for recirculating tracing systems.

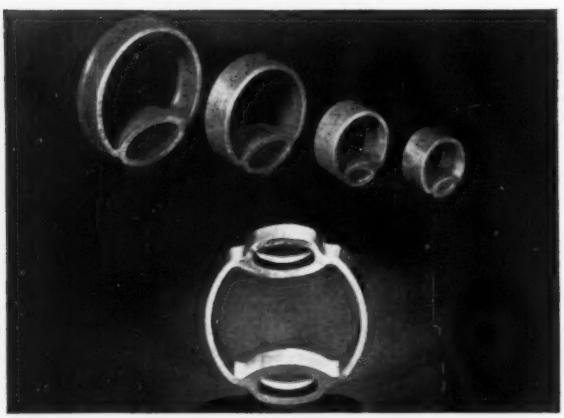
*Trademark of Aluminum Company of America

Today, the ingenuity of process industries designers has indicated intriguing new areas of potential use for both UNITRACE and DUOTRACE. Consider, for instance, the process economies which can result from the substitution of either UNITRACE or DUOTRACE for unit heat exchangers and preheaters.

Here you see an outstanding example of the way in which ALCOA is putting over 40 years of process industries experience to work to make aluminum your good design habit. You are invited to share that experience—through a series of engineering conferences which ALCOA is holding this year in a number of major cities. Your local ALCOA sales office will be happy to furnish details.

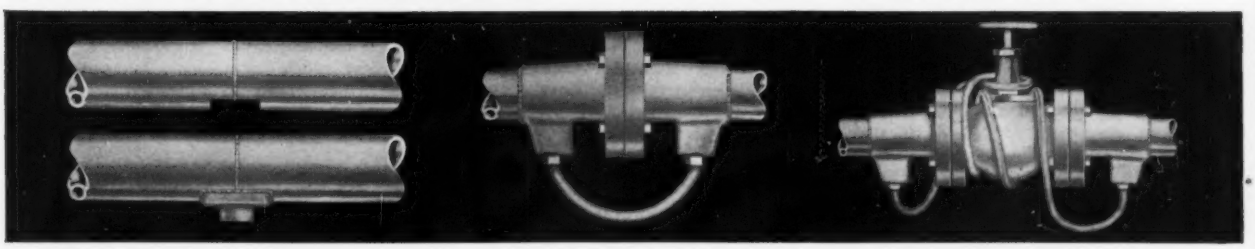
Take advantage, too, of the body of ALCOA literature which describes in technical detail the known performance characteristics of aluminum in a variety of process industries applications. Simply fill in and mail the coupon opposite. ALUMINUM COMPANY OF AMERICA, Alcoa Building, Pittsburgh 19, Pa.

World wide sales through ALCOA INTERNATIONAL, INC., 230 Park Avenue, New York 17, N.Y.

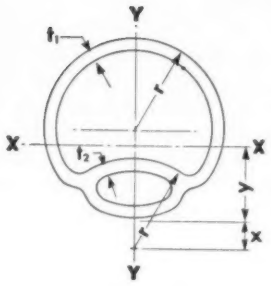


The development of DUOTRACE has opened broad new areas of design exploration in the field of heat transfer. By adding a second trace chamber to the one previously available in UNITRACE, DUOTRACE permits recirculation of the trace fluid. This opens up a whole new area of heat transfer design. Not the least of the possibilities is this: certain types of heat exchangers may now be extruded as single units. The cost savings implicit in such a unit are almost staggering. Alcoa engineers will be happy to assist you in exploring such design innovations in your own plant or process.

Fittings and connections for UNITRACE and DUOTRACE: Unflanged connections can be made easily and effectively with the special UNITRACE Trace Cap. As illustrated, trace chambers in adjoining sections are cut back and a circumferential weld is made to seal the product chamber. The cut back trace section is then covered with a UNITRACE Trace Cap welded in place with 4043 weld wire. Simple, efficient **flanged connections** utilize special UNITRACE flanges designed to accommodate both trace and product chambers. Jumper connections are used to carry the trace across the connection, and special impingement plates in the flange shield the product chamber from erosion as steam passes through the flange. **Valves, pumps and other fittings** can be incorporated into the traced systems by using UNITRACE flanges which mate with all 150-lb ASA flanges, valves and pumps. UNITRACE and DUOTRACE systems accommodate standard preformed pipe insulation.

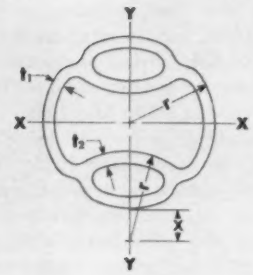


UNFLANGED CONNECTIONS FLANGED CONNECTIONS VALVES AND FITTINGS



	Unitrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Axis XX	Moment of Inertia (I) in.⁴	.09	.34	.72	2.71	6.52	31.82	81.82
	Radius of Gyration (R) in.	.37	.58	.72	1.09	1.42	2.12	2.78
	Section Modulus (S) in.³	.13	.34	.56	1.42	2.65	8.73	17.22
Axis YY	Moment of Inertia (I) in.⁴	.09	.33	.70	2.65	6.36	29.72	76.70
	Radius of Gyration (R) in.	.37	.57	.71	1.08	1.40	2.05	2.69
	Section Modulus (S) in.³	.14	.34	.59	1.52	2.83	8.97	17.79

Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
r	.657	.950	1.187	1.750	2.250	3.312	4.312
t_1	.133	.145	.154	.170	.187	.280	.322
t_2	.145	.163	.174	.185	.200	.307	.354
x	.133	.344	.406	.625	.813	1.500	2.000
y	.61	.87	1.08	1.59	2.03	2.98	3.87



	Duotrace Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
Axis XX	Moment of Inertia (I) in.⁴	—	—	.80	3.06	7.53	—	—
	Radius of Gyration (R) in.	—	—	.74	1.12	1.46	—	—
	Section Modulus (S) in.³	—	—	.68	1.75	3.35	—	—
Axis YY	Moment of Inertia (I) in.⁴	—	—	.67	2.59	6.29	—	—
	Radius of Gyration (R) in.	—	—	.68	1.03	1.33	—	—
	Section Modulus (S) in.³	—	—	.57	1.48	2.80	—	—

Sizes	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
r	—	—	1.187	1.750	2.250	—	—
t_1	—	—	.154	.170	.187	—	—
t_2	—	—	.174	.185	.200	—	—
x	—	—	.531	.843	1.125	—	—
y	—	—	—	—	—	—	—

Unitrace-Duotrace Sizes	1 in.	1½ in.	2 in.		3 in.		4 in.		6 in.	8 in.
Product Area (in.²)	.64	1.68	2.72	2.36	6.38	5.67	10.84	9.74	24.64	42.79
Trace Area (in.² each)	.10	.16	.35	.22	.98	.61	1.86	1.07	2.85	5.12
Metal Area (in.²)	.65	1.03	1.39	1.46	2.28	2.46	3.24	3.53	7.05	10.60
Weight (lb/ft)	.77	1.22	1.66	1.72	2.71	2.89	3.85	4.16	8.38	12.60
*Min. Bend Radii (in.)	5	8	10½	10½	17	17	24	24	36	48
Wetted Perimeter (in.)										
Product	3.35	4.92	6.31	6.28	9.68	9.65	12.72	13.02	18.63	24.75
Trace (each)	1.49	1.71	2.40	1.87	4.13	3.22	5.32	4.23	6.75	9.63
Fitting Weights (lb)										
Trace-Caps	.102	.126	.240	.13	.464	.40	.674	.55	1.67	2.92
Elbows	.706	1.347	2.111	2.65	5.244	6.59	9.649	11.68	27.76	52.51
Impingement Plates	.024	.039	.057		.101		.162		.22	.34
Stub Ends				.65		1.50		2.13		
Terminal Casting				.50		1.12		1.75		

	1–2 in.	1½–2½ in.	2–3 in.	3–4 in.	4–6 in.	6–8 in.
Adapter Flanges	2.419	3.816	4.774	7.216	11.106	19.23

(Note: UNITRACE values are indicated in clear areas in the table above. DUOTRACE values are shown in the shaded areas.)
*Unitrace may be bent in any direction to these radii provided reasonable tooling is employed.

Aluminum Company of America, 874-J Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries:

☐ 10197 Aluminum Pipe and Fittings
☐ 10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
☐ 514 Alcoa Duotrace Technical Report
☐ 10270 Alcoa Utilitube
☐ 10460 Process Industries Applications of Alcoa Aluminum
☐ 11453 Solving Refinery Corrosion Problems with Aluminum
☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
☐ 19416 Brazing Alcoa Aluminum
☐ 19415 Welding Alcoa Aluminum
☐ 19051 Alcoa Aluminum Handbook

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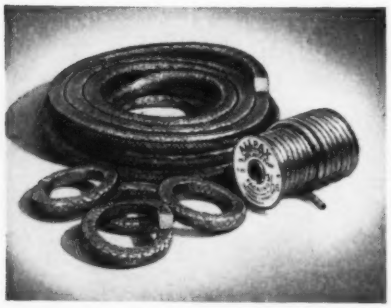
Company _____
Title _____
Address _____
City _____ Zone _____
State _____

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

For exciting drama watch "ALCOA THEATRE" alternate Mondays, NBC-TV, and "ALCOA PRESENTS" every Tuesday, ABC-TV

I'm an all-around "PETROLEUM PACKER"

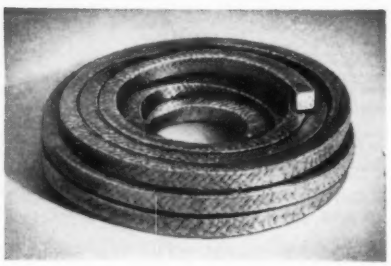
Petroleum service separates the men from the boys in the packing field—but you can count on Allpax Packings for this rugged service. They're the result of extensive laboratory research in the development of suitable packings for service against distillates and petroleum products. Recommended for use on centrifugal and rotary pumps, valve stems, swing joints and similar pumping equipment.



Style No. 14 – For regular petroleum service. Excellent against gasoline, light and heavy oils, benzol, toluol, etc. For temperatures up to 550 degrees F. Compounded of long asbestos fibres, fine flakes of graphite, and a special bonding compound containing an oil-resistant lubricant.

Style No. 13 – For extremes in high and low temperatures.

Style No. 30 – For use against petroleum products at high temperatures and pressures. A very dense packing, made by braiding jackets of asbestos yarn over a center core of pure asbestos content. The jacket is treated with a special heat-resistant compound. The outer jacket is lubricated with a coating of graphite.



ALLPAX

"The Packing that Packs All"

SEND FOR OUR NEW CATALOG — *TODAY!*

A complete line of packing, tools, gasket materials. Ask for dealer information and price schedules.

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 8, Quebec

Happenings . . .

perimentally, but the materials used have broken down fairly rapidly and have lost their effectiveness." He said that his company's system uses a high-impact isopolyester resin which binds the sound-producing rock chips in a tough, skid-resistant layer which should last five years or more.

Natural Gas Production Up 4% Above May 1959

The daily average production of natural gas liquids in May 1960 was 4 percent above May 1959, according to the Bureau of Mines, U.S. Department of the Interior. The daily average production of liquefied gases at refineries was 8 million gallons, 11 percent above May 1959.

Ethane-ethylene production in May was 8 percent above May 1959. The daily average demand for liquefied gases for fuel and chemical uses increased 6 percent from May 1959. Stocks of liquefied gases excluding ethane totaled 889 million gallons, an increase of 178 million gallons during May 1960. Underground stocks of liquefied gases totaled 607 million gallons, 10 million less than a year ago.

The daily average demand for natural gasoline was 11 million gallons, an increase of 4 percent from May 1959.

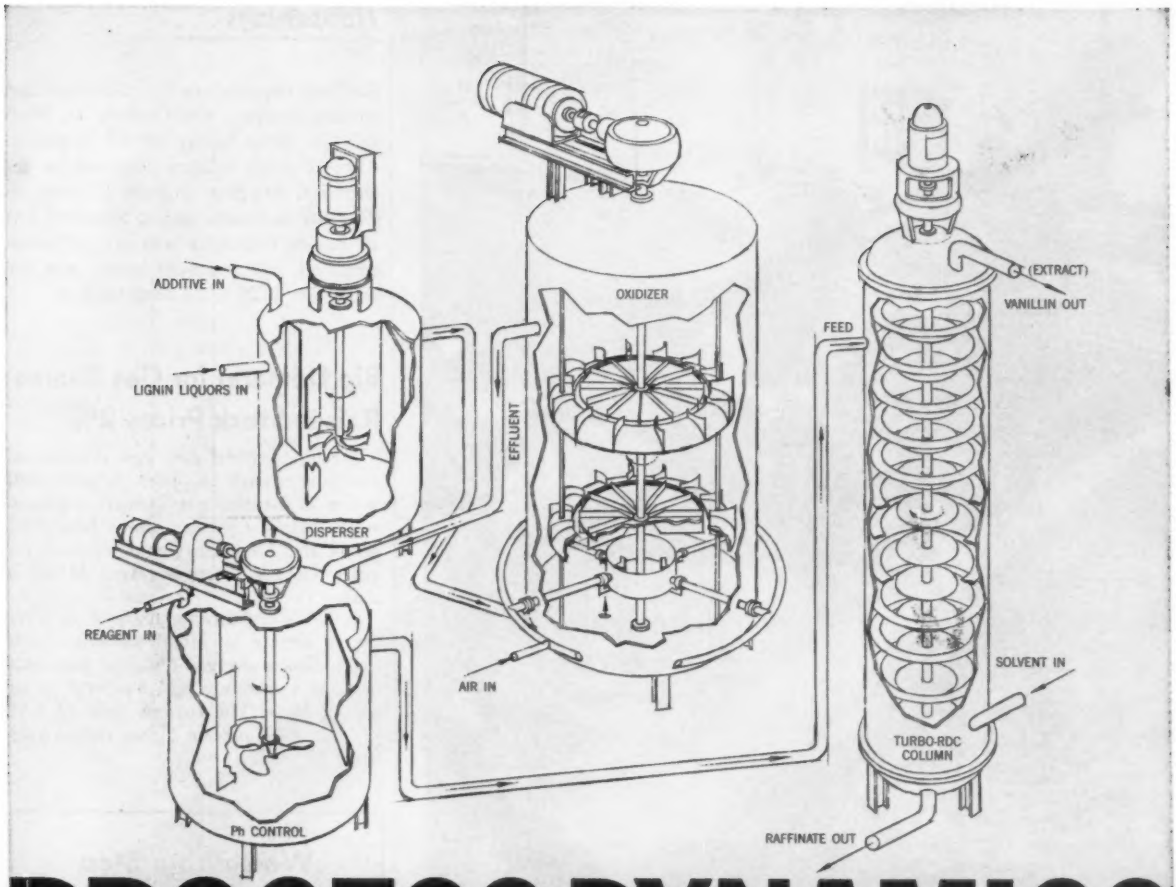
Crude Demand Rises 3% Over Last Year

Total domestic and export demand of crude during May, June and July averaged 9,180,000 bpd, up 271,000 or 3 percent from the same months last year. All products except residual fuel oil, which was down 2 percent, show good increase, the Independent Petroleum Association of America reports. IPAA expects the total demand for the next three months to average 9,700,000 bpd as normal seasonal increase begins. This would be an increase of 244,000 bpd or 2.6 percent over the same period in 1959.

The total petroleum supply required for the next three months is estimated at 9,650,000 bpd. This would be 250,000 bpd higher than in August and about 150,000 higher than in the same three months last year.

OCAW Probes Refinery Lay Offs, Wage Cuts

Federal investigation into oil companies' plans to lay off refinery employes



PROCESS·DYNAMICS

A new concept for evaluation and control of **Equipment** and **Process Performance**

General American's wide diversification permits the design of equipment for *controlled performance* and *process in transport*. This diversification plus specialized experience and extensive laboratory facilities assures you of correct equipment construction and maximum utilization of automated systems.

Our engineers, with their broad experience in equipment and process specialties, are ready to work with yours to provide any of the listed equipment and systems, and to install them anywhere in the world.

Unified responsibility as provided by General American means greater efficiency, fewer complaints, improved coordination and far less down-time than you can possibly get when your equipment is furnished by a variety of suppliers.

TURBO-MIXER GENERAL AMERICAN TRADE MARK

Process Equipment Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street
Chicago 3, Illinois
Offices in principal cities

TURBO-MIXERS—LOUISVILLE PROCESS EQUIPMENT—TRAYLOR ENGINEERING—FULLER COMPANY—DRACCO DIVISION—SUTORBILT—KANIGEN CHEMICAL PLATING—PLATE & WELDING—WIGGINS CONSERVATION STRUCTURES—FIELD ERECTION DIVISION—blowers • compressors • conservation systems • conveying systems • coolers • crushers • cryogenic equipment • crystallizers • dewatering presses • dryers • dust control equipment • evaporators • extraction equipment • fans • fractionating columns • gas absorbers • gasholders • mixers • preheaters • pressure vessels • pumps (gas and vacuum) • rock product processing equipment • storage tanks (floating, fixed and lifter roofs)

For more data on advertised products, use Readers' Service Cards, last page.

8 A-W cranes serve Shell refineries

Shell Oil Company has eight Austin-Western hydraulic cranes—at six different refineries in the U. S. One crane is shown above at its Martinez, Calif., plant.

All-wheel steering

A-W cranes are ideal for hundreds of lift, carry and place jobs in any refinery. All-wheel steering means remarkable maneuverability in tightest quarters. Low clearance eliminates need to dismantle overhead pipes to permit passage of long boom cranes. Telescoping boom retracts and extends hydraulically; reaches into spots otherwise inaccessible except for hand work or block-and-tackle. Boom swings in continuous full circle.

It is self-propelled, rubber-mounted; travels at speeds up to 35 mph. Easy to operate. So precise it can even line up bolt holes when setting pumps and valves; holds pipe accurately for welding.

Tops for construction, maintenance or materials handling. Economical, easy to maintain.

Five models

A-W cranes are available in five models with capacity ranges from 5 to 11 tons. Optional attachments include magnet, clamshell, personnel platform, many others. Ask your nearest A-W distributor for facts, figures and a demonstration or specific information.

Austin-Western

CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

Happenings . . .

has been requested by Oil, Chemical and Atomic Workers. On October 31, Shell Oil Co. plans to lay off 27 employes. Also, 26 other refinery jobs will be reclassified, bringing cuts of 20 cents to 73 cents in hourly wages. Standard Oil of British Columbia will lay off seven employes and reclassify seven jobs for wage cuts of 20 to 25 cents an hour.

Big Demand for Gas Shares Raises Stock Prices 2%

Strong demand for gas distribution company shares in June helped push prices of natural gas industry common stocks nearly 2 percent above June 1959 levels, the American Gas Association reports. Closing prices averaged $48.05 a share.

A.G.A.'s monthly summary of data reported weekly by Moody's Public Utilities indicates average dividend payments of $2.18 a share are up 7.4 percent on an annual basis. The current yield of 4.54 percent is 5.3 percent higher than a year ago.

Watch Your Step

145,300 workers were killed on the job and 19,500,000 workers suffered injuries disabling beyond the day of the accident during the decade of 1950-59, the National Safety Council's 1960 statistical yearbook, "Accident Facts," reports. The accident toll during the 1950's said the council, was 5,000 less than the toll during the preceding 10 years. The decrease was brought about in the face of a substantial rise in employment during the decade.

Sept. Domestic Crude Use Forecast At 7 Million bpd

U.S. domestic crude consumption or exportation in September is estimated at 6,980,000 bpd, compared with 7,125,000 bpd forecast for August by the Bureau of Mines, U.S. Department of Interior. Crude runs to stills for July were 8,260,000 bpd including foreign runs of 1,085,000 bpd. The bureau reports that the demand for domestic crude in July was 7,165,000 bpd with production of 6,834,000 bpd.

For more data on advertised products, use Readers' Service Cards, last page.

This is THERMAL FATIGUE

This photograph shows a heat-resistant furnace tube after thermal fatigue failure.

Thermal fatigue failure begins with cyclical temperatures and variable heat inputs. These conditions produce nonuniform thermal expansions and contractions. As a result, strong, hindered expansion and contraction stresses develop. These stresses produce plastic flow which results in the tube deformation shown above. Deformation of this type curtails furnace operations and constitutes thermal fatigue failure. Progressive deformation or severe thermal fatigue stresses will cause tube-rupture failures.

Thermal fatigue is an inherent problem in heat-resistant components, cast or wrought. As such, it occupies an important place in Electro-Alloys research efforts to lengthen life of components working under high temperatures and severe cyclical conditions.

We have created apparatus that assesses and analyzes the variables of thermal fatigue. Check with your Electro-Alloys representative for the meaning of our thermal fatigue data as it pertains to the material specification, design and service conditions of your heat-resistant components.

Send for free technical booklet on Thermal Fatigue

Please send me free copy of "The Mechanism of Thermal Fatigue," by Howard S. Avery—comprehensive report based on extensive lab studies:

Name_____

Title_____

Company_____

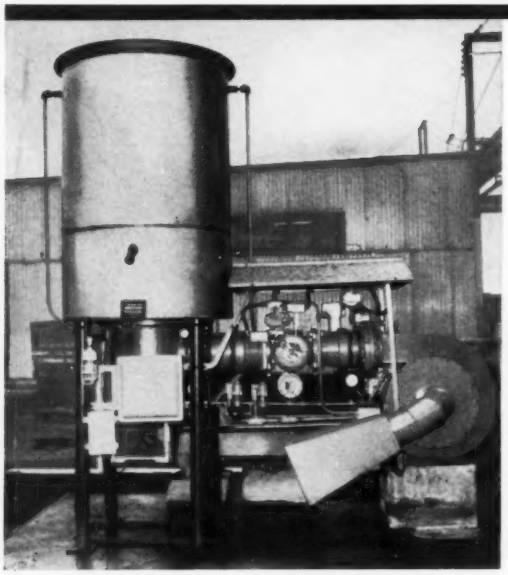
Address_____

City_____ State_____

Electro-Alloys, 2029 Taylor St., Elyria, Ohio

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio



Packaged THERMAL Waste Burner System installed at The Trubek Laboratories Inc. is used to burn waste solvents and mixed aromatics. It provides automatic and complete, odor-free incineration.

SOLVE CHEMICAL DISPOSAL PROBLEMS

with a **THERMAL**

WASTE BURNER SYSTEM!

Long established as one of the most efficient heat sources available to industry, THERMAL high heat release burner equipment provides rapid, efficient, economical incineration of combustible liquid and gaseous wastes. Because of its unique design, wastes can be fed directly into the burner, eliminating the need for bulky, expensive incinerators. THERMAL installations are compact, flexible and require minimum maintenance. Efficient heat recovery can also be arranged. Find out how this system can solve your waste disposal problems. Write today for information.

THERMAL WASTE DISPOSAL SYSTEMS have proved their effectiveness with these waste materials:

GASEOUS	LIQUID
Wax kettle fumes	Acetone-Acetic acid mixture
Phosgene	Ethyl alcohol
Smelter fumes	Phenol still residues
Hydrogen Sulfide	Diethylenetriamine Tar
Plastic plant wastes	Paint & Lacquer residue
Ammonia fumes	Organic insecticide wastes
Phthalic Anhydride	Nitrated & chlorinated aromatics
Acetylene, methane & hydrogen mixture	Ethyl ether
Carbon disulfide vapors	Dimethylformamide & formic acid
	Benzene

✳ Use THERMAL's extensive lab facilities for trial burnings of your waste materials. Our engineering staff is available to do complete turn-key designs to meet your specific needs.

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

Other Thermal Products & Services:

- Gas, Oil & Combination Burners
- Heat Exchangers
- Air Heaters
- Gas Generators
- Submerged Combustion
- Combustion & Heat Transfer Equipment

Happenings . . .

World Refining Capacity Set At Over 23 Million bpd

Total refining capacity of the world has been placed at 1,168,665,000 tons or about 23,373,300 bpd, at the end of 1959 compared with a 1958 total of 1,081,750,000, or about 21,635,000 bpd, by the Petroleum Information Bureau. Both domestic and foreign capacities were estimated at about 667 million tons held by United States companies, and approximately 182 million tons was accredited to British and associated Dutch firms.

Two Killed From Blast At Utah Refining Plant

Two men were killed and an estimated damage of $250,000 resulted from an explosion and fire that occured at Utah Oil Refining Co.'s plant at Salt Lake City, Utah, August 19. Damage to the plant's catalytic cracking unit has reduced refinery output for about 30 days.

- Changing Times -

A joint company is being formed by Shell International Chemical Co., Ltd., and National Distillers and Chemical Corp. to develop plans for the production and marketing of polyolefin film and packaging materials outside the United States and Canada.

A license agreement to manufacture and market a revolutionary electrochemical system for controlling corrosion has been concluded by Continental Oil Co. with Minneapolis-Honeywell Regulator Co.

Natural Gasoline Association of America has been named a winner of the National Safety Council's Association Award for 1960. It was one of 10 associations, representing various industries in the United States and Canada, cited by the council.

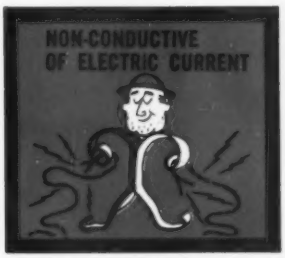
Witco Chemical Co., Inc., acquires 100 percent interest in Sonneborn Chemical and Refining Corp. in exchange for 300,000 shares of Witco stock . . . Canadian Husky Oil, Ltd., buys 87 percent of Husky Oil Co. common stock through offer to exchange eight common shares for each nine shares of Husky Oil stock.

Interests of Walter B. Moran and associates in a gasoline plant at Kendrick,

PLICOFLEX LAMINATED

Pipe Protective Tape

Plicoflex butyl-vinyl laminated pipe protective tape guards your pipe under all conditions. Plicoflex tape is



The liquid butyl Plicoflex primer and flexible butyl underlayer fill in all pipe surface irregularities for positive coverage.

The vinyl outer layer increases resistance to

Try Plicoflex on your next pipe protective job, you'll find it goes on easily, that total costs are low and that it gives the best protection available to your pipe.

10 colors, 4 thicknesses available.

Write for descriptive literature or demonstration.

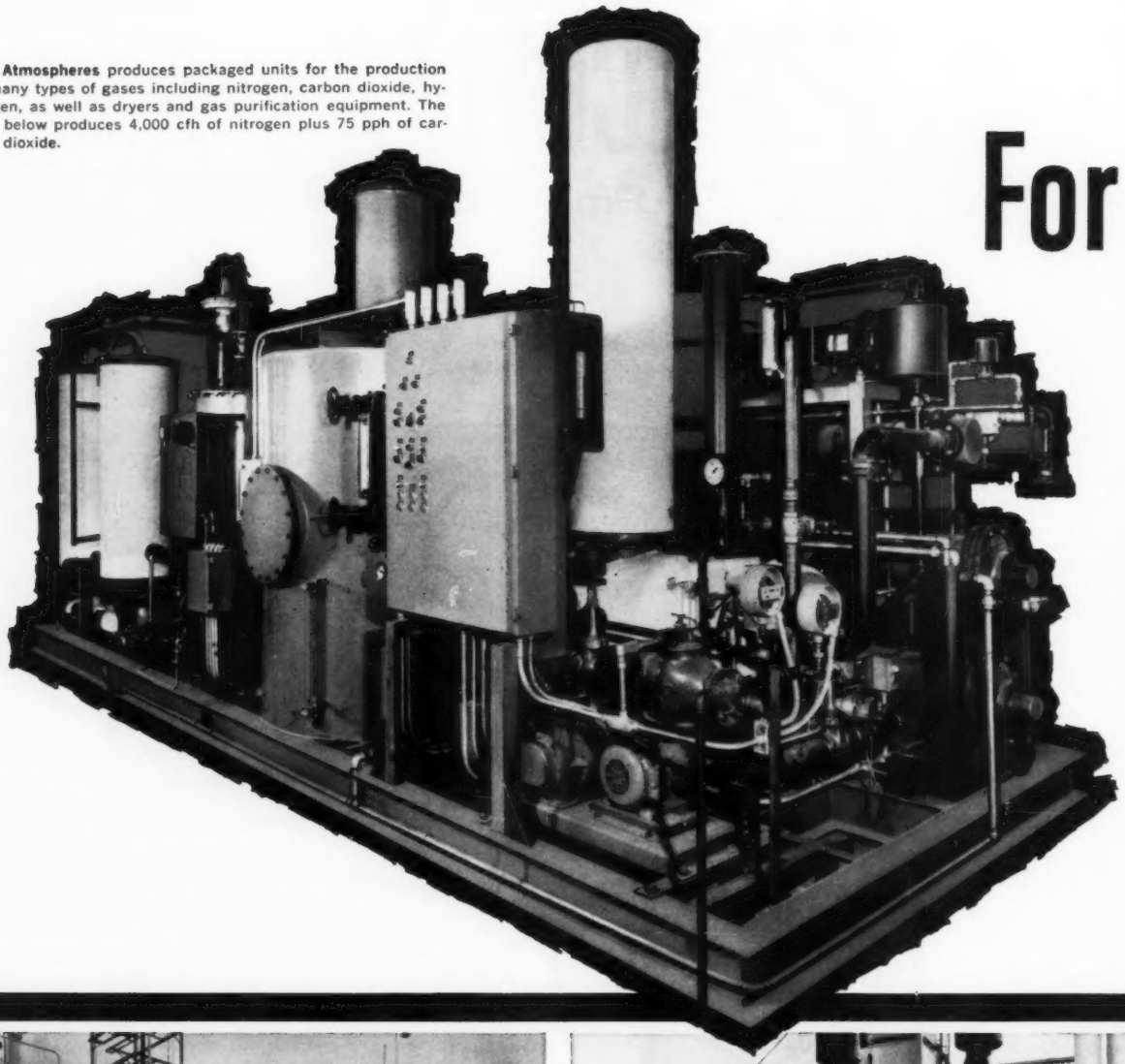
PLICOFLEX, INC.

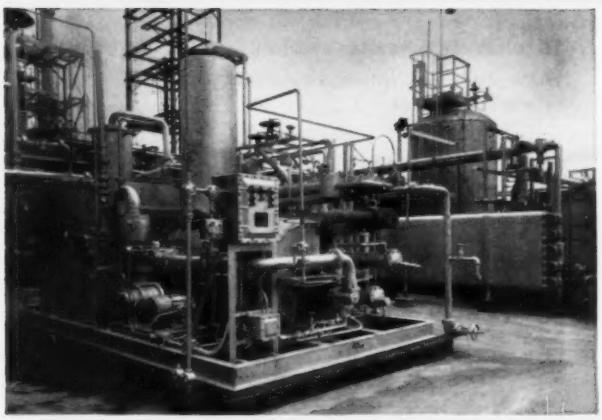
2425 Mowery Rd. P. O. Box 45911 Houston 45, Texas
JAckson 6-3711 Teletype HO 277

For more data on advertised products, use Readers' Service Cards, last page.

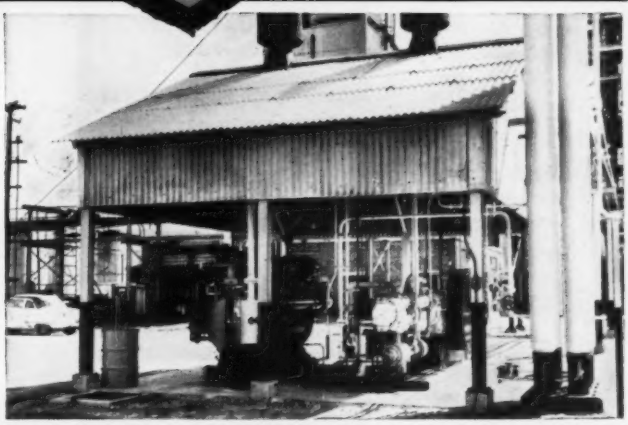
Gas Atmospheres produces packaged units for the production of many types of gases including nitrogen, carbon dioxide, hydrogen, as well as dryers and gas purification equipment. The unit below produces 4,000 cfh of nitrogen plus 75 pph of carbon dioxide.

For





Texaco, Inc. uses this 10,000 cfh nitrogen/carbon dioxide Gas Atmospheres generator in the production of oil additives. A new 20,000 cfh unit was recently delivered.



Esso Standard Oil has several Gas Atmospheres inert generators to supply gas for blanketing storage areas. This 10,000 cfh unit is at their Baton Rouge refinery.

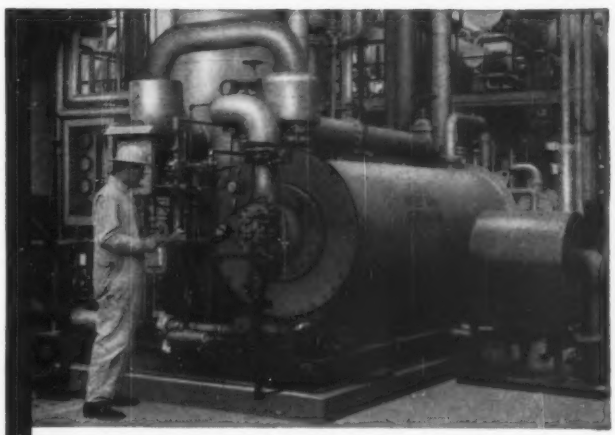
Petroleum Processors!

Gas Atmospheres engineers industry's most complete line of "Packaged" Gas Generators

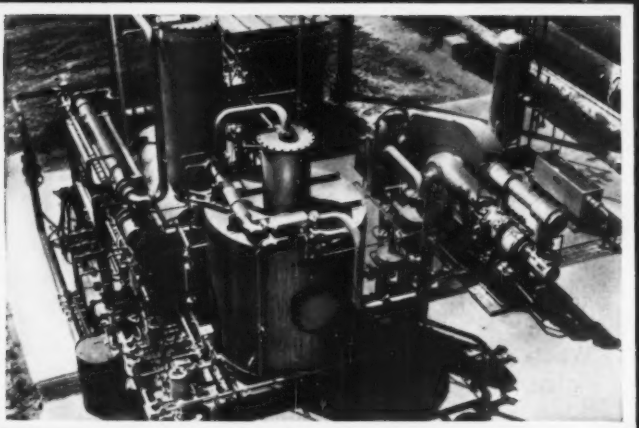
Originators and leading producers of packaged gas generation systems, Gas Atmospheres now offers petroleum processors and refiners the most complete line of compact atmosphere gas generators available.

The demand for more refined fuels and safer processing practices has interested the industry in producing their own gases to get greater volume at reduced costs. Gas Atmospheres engineers have worked with many leading petroleum processors and refiners to engineer and provide the most exacting and efficient factory tested, packaged atmosphere systems possible.

If controlled atmospheres are part of your future —why not deal with the leaders—call in our representative soon. Contact *Gas Atmospheres, Inc., 3855 West 150th Street, Cleveland 11, Ohio.*



Tidewater Oil Company gets all the gas they need, most economically, by producing their own in this 70,000 cfh packaged Gas Atmospheres inert generator.



Humble Oil Company uses this 10,000 cfh Gas Atmospheres nitrogen generator to produce gas for purging lines and blanketing storage.

YOU GET UNSURPASSED EXPERIENCE, TOO, WHEN YOU CALL GAS ATMOSPHERES

Partial List of Gas Atmospheres Petroleum Processing and Refining Customers

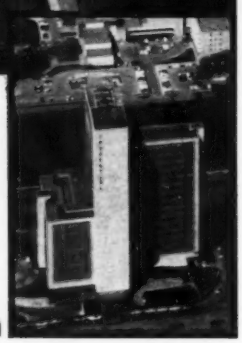
Compagnia Termica (Italy)	Shell Oil Company
Esso Standard Oil Co.	Standard Oil of California
Ethyl Corporation	Standard Oil of Indiana
Humble Oil & Refining Co.	Standard Oil of New Jersey
Kendall Refining Co.	Standard Oil of Ohio
Lubrizol, Inc.	Standard Vacuum Oil Co. (So. Africa)
Mobil Oil Co.	Texaco, Inc.
Nynas Petroleum (Sweden)	Tidewater Oil Co.

gas Atmospheres, inc

equipment for producing industrial gases

For more data on advertised products, use Readers' Service Cards, last page.

Performance Proved



on Prudential Building
and many other
installations in Houston

Throughout Houston, the air conditioning capitol of the world, and the Gulf area, Hartzell cooling tower fans are being used in many commercial and industrial installations such as the one on top of the Prudential Building.

This 14′, 6-blade assembly is operating in an induced draft tower and has given *completely trouble-free service during its 6½-year life time.*

Here is another example of the kind of *service and long-life bonus* many owners of Hartzell fans have welcomed in their cooling towers and heat exchangers in the Houston area. Whatever your requirements for large diameter fans and cooling capacity, Hartzell has the fan to do the job.

HARTZELL

Engineering Offices in Principal Cities

HARTZELL PROPELLER FAN CO.

Div. of Castle Hills Corp. Piqua, Ohio

Changing Times (continued)

Okla., have been bought by Apache Gas Products, Tulsa, a subsidiary of Apache Corp. Co-owner of the plant is Warren Petroleum Corp.

A program of increasing investments in petroleum and allied or complementary industries is being stepped up by Union Oil Co. of California. The increase will give the company greater geographical and product diversification, R. H. Taylor, president and chairman, said.

Education grant of $175,000 awarded to 159 private liberal arts colleges in 13 states by Standard Oil Foundation . . . Ford Foundation gives $700,000 to Polytechnic Institute of Brooklyn for science-engineering honors program . . . $2,000 in college scholarships given by Continental Oil to 16 high school grads in six states.

A grant of 199 scholarships for the 1960-61 academic year has been awarded by the Henry L. Doherty Educational Foundation at over 100 colleges. The foundation is supported by Cities Service Oil Co. employes and the Cities Service company.

Aid to Argentina's National Institute of Industrial Technology will be provided by Armour Research Foundation. Argentine industry, under this arrangement, will have access to the research facilities at a nominal charge. The institute is semi-government supported.

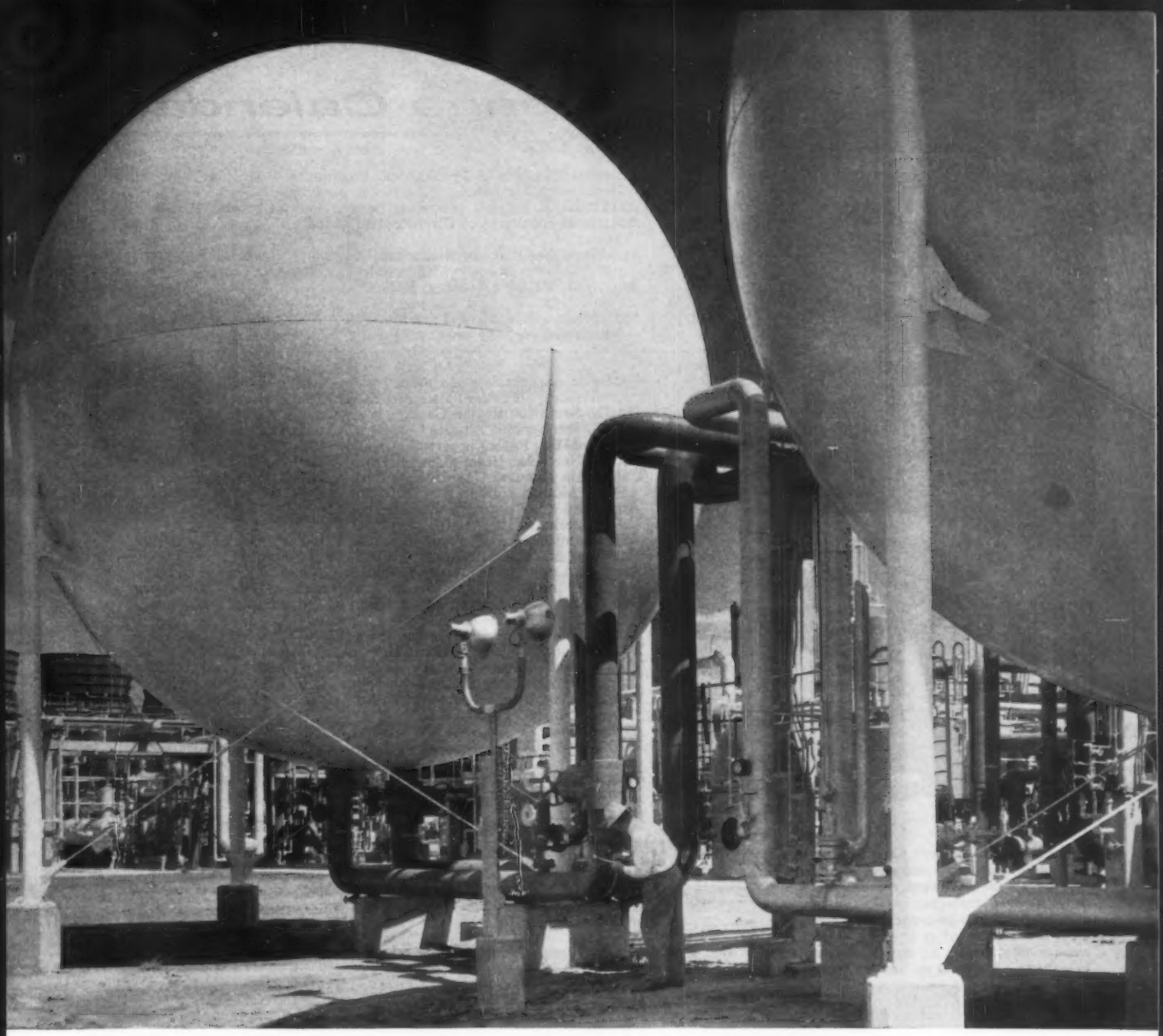
$17.2 million worth of petroleum supplies has been delivered to nations under the Military Assistance Program by the U.S. Air Force. Twelve nations were authorized to receive specified items in accordance with predetermined needs.

Gulf Oil Corp. acquires Wilshire Oil Co., independent marketer and refiner, Los Angeles. Wilshire Oil operates principally in California. Through acquisition of Wilshire, Gulf will be able to take part in fast-growing Western market.

A series of lectures by scientists will be made possible during the 1960-61 academic year at the University of Tulsa by a grant from the Esso Education Foundation.

Oil industry is ranked second only to food industry in price discrimination and monopoly, according to Earl W. Kintner, chairman of the Federal Trade Commission.

For more data on advertised products, use Readers' Service Cards, last page.



Where high pressure is the problem

a Graversphere is the answer

For the pressure storage of process butane, iso-butane, natural gasoline and other volatile liquids and gases, Graverspheres are the answer.

Large capacity . . . require less ground space, fittings and piping.

Graverspheres are precisely formed in Graver's shops. They are then shipped to location, erected and field X-rayed. Available in capacities from 1,000 to 45,000 bbl.

If you have a gas or liquid storage problem, Graver-engineered . . . Graver-built . . . Graverspheres may be your answer. May we quote on your requirements?

Graver

DIVISION—UNION TANK CAR COMPANY

Graver Tank & Mfg. Co.

EAST CHICAGO, INDIANA

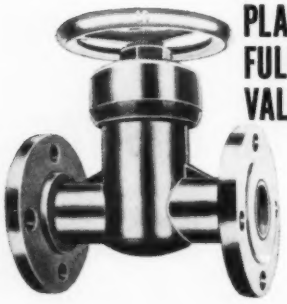
PLANTS AND OFFICES ACROSS AMERICA

DEPENDABLE
VALVES for TIGHT SEALING
in those
TOUGH PROCESS APPLICATIONS

PENTON COATED DIAPHRAGM VALVE

This valve uses a rubber diaphragm to seal the fluid in valve body and a rubber covered disc to close the valve tight. Penton coating of body provides protection against corrosive action. Valve has high capacity—low pressure drop. Available in ½" to 6" sizes; manual or mechanical operators. Air diaphragm operated unit shown here. Write for Bulletin 800C.

ALL PLASTIC FULL FLOW VALVE



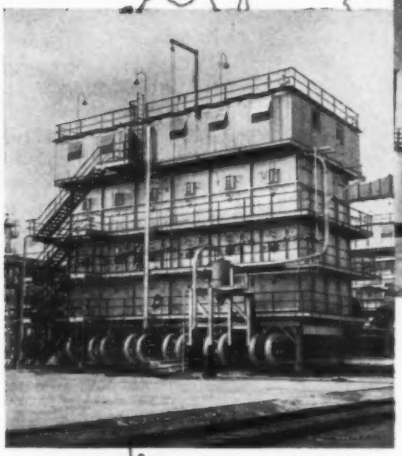
Valve with body in wide choice of plastics. Soft rubber or elastomer plunger seals off fluid flow. Full straight-thru design, with no obstructions or reduction in cross section area when full open, minimizes pressure loss. Sizes 1" to 2". Write for Bulletin 802D

W. S. ROCKWELL CO.

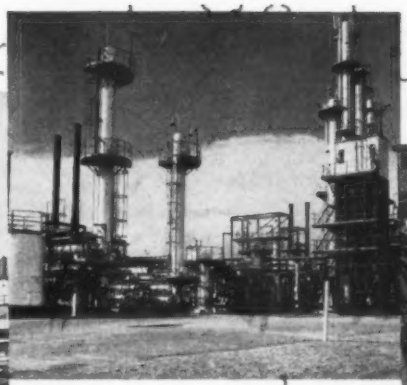
2420 Eliot St., Fairfield, Conn.

Meetings Calendar

Sept.	
18–21	**American Society of Mechanical Engineers,** Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans.
21–23	**ASME-AIEE,** Power Conference, Bellvue-Stratford Hotel, Philadelphia.
25–28	**American Institute of Chemical Engineers,** Meeting, Mayo Hotel, Tulsa.
25–28	**American Institute of Electrical Engineers,** Electrical Conference of the Petroleum Industry, Hotel Skirvin, Oklahoma City.
26–30	**American Welding Society,** National Fall Meeting, Hotel Penn-Sheraton, Pittsburgh.
26–30	**Instrument Society of America,** Fall Automation-Instrument Conference and Exhibit, Annual Meeting, New York Coliseum, New York.
Oct.	
6– 7	**National Association of Corrosion Engineers,** Annual Western Region Conference, Sheraton-Palace Hotel, San Francisco.
6– 8	**NACE,** Southeast Region Conference, Dinkler-Plaza Hotel, Atlanta, Ga.
9–12	**ASME,** Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.
10–11	**ASME-AIEE,** Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.
11–14	**NACE,** Northeast Region Conference, Prichard Hotel, Huntington, W. Va.
13–14	**California Natural Gasoline Association,** Fall Meeting, Hotel Miramar, Santa Monica, Calif.
17–19	**American Oil Chemists' Society,** Fall Meeting, Hotel New Yorker, New York.
17–19	**ASME,** Lubrication Conference, Statler Hilton Hotel, Boston, Mass.
17–21	**National Safety Council,** Annual Meeting, Conrad Hilton Hotel, Chicago.
–18	**American Society of Safety Engineers,** Annual Meeting, Chicago.
19–20	**NACE,** Conference, North Central Region, Pfister Hotel, Milwaukee.
20–21	**Gas Compressor Engine Short Course,** University of Oklahoma, Norman, Oklahoma.
24–25	**ASME,** Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.
25–28	**NACE,** South Central Region Conference, Mayo Hotel, Tulsa.
26–27	**Western Petroleum Refiners' Association,** Question and Answer Session on Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.
–28	**Natural Gasoline Association of America,** Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
–28	**AIChE,** South Texas Section Technical Meeting, Rice Hotel, Houston.
31–Nov. 2	**ISA, AIEE, IRE,** Conference, Electrical Techniques in Medicine and Biology.
31–Nov. 2	**National Lubricating Grease Institute,** Annual Meeting, Edgewater Beach Hotel, Chicago
31–Nov. 2	**Society of Rheology,** Annual Meeting, Mellon Institute, Pittsburgh, Pa.
Nov.	
14–16	**American Petroleum Institute,** Annual Meeting, Conrad Hilton, Palmer House, and Congress Hotels, Chicago.
–18	**NGAA,** Panhandle-Plains Regional Meeting, Herring Hotel, Amarillo, Texas.
27–Dec. 2	**ASME,** Annual Meeting, Statler Hilton Hotel, New York.
Dec.	
4– 7	**AIChE** Meeting, Hotel Statler, Washington.
7–11	**NACE,** University of Illinois Corrosion Control Short Course, Urbana Campus.
12–14	**U.S. Public Health Service,** National Conference on Water Pollution. Sheraton Park Hotel, Washington, D.C.
Jan. 1961	
16–19	**ISA,** Conference & Exhibit, Winter Instrument-Automation, Sheraton-Jefferson Hotel, Kiel Auditorium, St. Louis, Mo.
–20	**NGAA,** Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi, Texas.
Feb.	
–24	**NGAA,** South Louisiana Regional Meeting, Lafayette Petroleum Club, Lafayette, La.
26–Mar. 1	**AIChE,** Petrochemical and Refining Exposition, Municipal Auditorium, New Orleans, La.
Mar.	
–11	**AIChE, American Chemical Society,** Joint Technical Meeting, Lamar State College, Beaumont, Texas.
13–17	**NACE,** Annual Meeting & Corrosion Show, Hotel Statler, Buffalo, N.Y.
15–17	**NGAA,** Annual Convention, The Baker Hotel, Dallas, Texas.
21–30	**ACS,** National Meeting, St. Louis, Mo.
27–31	**ISA,** Symposium on Temperature—Its Measurement and Control in Science and Industry, Veterans' Memorial Auditorium, Columbus, Ohio.
April	
17–19	**ISA,** National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas.
–28	**NGAA,** Oklahoma Regional Meeting, Lake Murray Lodge, Ardmore, Okla.



One of two 15 million cubic feet per day Girdler hydrogen reformers at a Delaware refinery.



Girdler hydrogen plant, a part of catalytic reformer installation in Gilsonite, Colorado.

Three large hydrogen plants have been built at widely separated locations for the Nitrogen Division of Allied Chemical Corporation.

HYDROGEN

In the last decade, most of the hydrogen plants installed in the United States and Canada have been built by Girdler.

This performance alone provides undisputed evidence of Girdler's ability and know-how and assures you of dependable design, engineering and construction. You can count on Girdler to help you when you're considering a new plant, or enlarging your present facilities for producing hydrogen or synthesis gases for ammonia, methanol, oxo-process, etc.

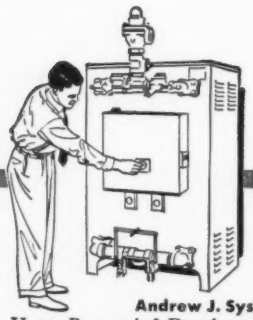
GIRDLER CORPORATION
P. O. Box 174
LOUISVILLE 1, KENTUCKY

For complete information, write or wire today for this free 36 page book all about hydrogen and its production.

GIRDLER

chemical processes and process plants

For more data on advertised products, use Readers' Service Cards, last page.



Andrew J. Syska,
Hayes Research & Development Engineer Reports . . .

KNOW-HOW IS VITAL IN GAS AND LIQUID DRYING

When we developed the Molecu-Dryer®—a unit specially designed to take advantage of the remarkable drying, sweetening, and purifying capabilities of Linde Company's Molecular Sieves—our chief interest was in drying protective atmospheres (hydrogen, dissociated ammonia, etc.) for metallurgical work—to dewpoints well below –100°F. A natural outgrowth of the Molecu-Dryer was the *Nitro-Gen*®—an automatic cycling generator which produces low cost, high purity nitrogen for blanketing, purging, protecting. Our engineering people have also explored whole new worlds of gas, liquid, and atmosphere drying and separating problems.

NEW DRYING NEEDS APPEAR DAILY

In manufacturing transistors, for example, the Molecu-Dryer has been able to effect big economies by supplying moisture-free air in place of tank nitrogen to protect transistor assembling and sealing operations. Other current projects: instrument air drying, gaseous CO_2 drying, gas separating . . . also drying and separating of liquid or gaseous hydrocarbons.

EQUIPMENT DESIGN IS DYNAMIC!

Each new area of work has necessitated engineered application of standard or special Molecu-Dryer models, to provide optimum adsorption efficiency, top capacity at minimum equipment cost, job-coordinated cycle times, and fast desorption and cooling.

Linde MOLECULAR SIEVES

For a comprehensive picture of the Molecu-Dryer, write for Bulletin 5703.

*Hayes TM

C. I. HAYES, INC.
853 Wellington Avenue • Cranston 10, R. I.
Established 1905

ELECTRIC FURNACES

It pays to see HAYES for metallurgical guidance, laboratory facilities, furnaces, atmosphere generators, gas/fluid dryers.

Men In Industry...

V. W. Fletcher has been elected vice president, Asiatic Petroleum Corp. He succeeds **S. J. Veenstra,** who has resigned to take a position with Shell International Petroleum Co., London. Fletcher will be responsible for the materials purchasing, traffic and technical service departments. He joined Asiatic Petroleum in 1950. He began his career in 1926 with the Caribbean Petroleum Co., and has served in Venezuela, Colombia, Ecuador, Borneo and Great Britain.

Fletcher

Finn Haaskjold has accepted a position as research engineer in the engine lubricants section, Richmond Laboratory, California Research Corp. **Lawrence E. Santucci, Jr.,** has completed work toward an M.S. degree in bituminous materials at Cornell University and has joined the Richmond Laboratory staff as research engineer in fuel oils, asphalts and special products.

Bruce K. Brown, who served as deputy administrator of the Petroleum Administration for Defense during the Korean War, has resigned as chairman of the board of Petroleum Chemicals, Inc., New Orleans, to become a business consultant. He is a former vice president and director of Standard Oil Co. (Indiana).

E. W. Bowerman, former assistant head of research and development for Enjay Chemical Co., a division of Humble Oil & Refining Co., has been named product manager of the Chemical Raw Material Division on a rotational assignment. The Chemical Raw Materials Division handles ethylene, butadiene and similar chemical raw materials.

Lee P. Morris has been named assistant manager of Standard Oil Co.'s (California) Hawaiian refinery. Morris goes to Hawaii from Grand Junction, Col., where he has spent four years as refinery manager for the American Gilsonite Co. He joined Standard after graduating from the California Institute of Technology in 1934. He served five years in the U.S. Navy during World War II.

Morris

Marvin W. Crowe has been promoted to director of personnel development and safety, Continental Oil Co. Formerly director of training for Conoco's Manufacturing Department, he will continue to make his headquarters in Houston. Crowe will serve as director of personnel development and, in addition, assumes administrative responsibility over the activities of the company's Safety Division. **Carl B. Adams** will continue as director of safety and chief fire marshal, with headquarters at Ponca City, Okla., and will report to Crowe. Crowe joined Conoco at Lake Charles, La., in 1954 and served in refinery engineering positions before his promotion to fire marshal and safety supervisor at that location in 1956. He transferred to Houston three years later as director of training for the company's Manufacturing Department.

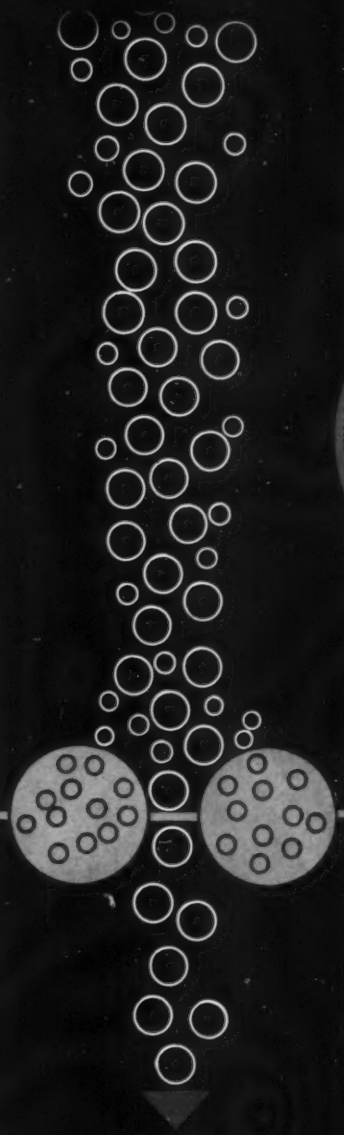
Hjerpe

Taylor

Eric B. Hjerpe has been appointed director, Operations Planning and Scheduling Division, Gulf Oil Corp.'s Port Arthur refinery. He replaces **Marvin L. Ralston** who recently transferred to general offices in Pittsburgh. **Herman Taylor, Jr.,** has been named supervisor, special projects section, Process Engineering Division, to replace Hjerpe. Hjerpe joined the Port Arthur refinery in 1935, and Taylor started in the laboratory and technical service departments of Gulf in 1943.

W. Rolland Stewart, vice president and general manager, Bay Refining Co., is ending his association with Bay Refining to devote full time to other business enterprises with which he is connected. Stewart said he plans to resume participation in various Midwestern petroleum producing firms. He has been vice president and general manager of Bay Refining since joining the firm in 1945.

Dr. Adalbert Farkas, assistant director of research, Houdry Process Corp., Philadelphia, has been elected president of the International Congress on Catalysis, Inc. Dr. Farkas, an inter-



One-stage purification delivers

ETHYLENE WITH LESS THAN 1PPM OF CO_2

...WHEN YOU ADSORB WITH LINDE

MOLECULAR SIEVES

This is only one of many applications which utilize the high capacity and selectivity of LINDE Molecular Sieves. In fact, Molecular Sieves not only outperform other adsorbents, but do other adsorption jobs never before accomplished. Whether in new installations or as replacement adsorbent in existing units, Molecular Sieves can help you minimize both investment and operating costs. More specifically, here's how they are used. . . .

A major petrochemical company has reduced the CO_2 content of its ethylene from 3000 PPM to less than 1PPM. This high purity is achieved in a single-stage process, automatic and non-corrosive, which has proved to be more economical than the alternative four-stage process. Other petrochemical uses include drying of cracked gases, ethylene, hydrogen, liquid propylene, solvents and many other gases and liquids. **Natural gas producers** use Molecular Sieves for drying and sweetening of natural gas, for sweetening of liquid propane and butane, and for drying of adsorber oil. **Petroleum refiners** use them to gain efficiency in drying reformer hydrogen, liquid butane LPG and transformer oil, and for removal of impurities such as CO_2 and mercaptans **Refrigeration manufacturers** use Molecular Sieves as a desiccant in super-drying refrigerants to eliminate freeze-up and corrosion.

For these and many other adsorbent applications, you can rely on patented LINDE Molecular Sieves to perform more effectively. They are the top quality material of their kind available today, always uniform, with high capacity, high strength, and high bulk density. They are available in regular and special grades to meet your specifications.

LINDE technical know-how—gained from years of laboratory and field work with adsorption problems—can help make Molecular Sieves work profitably for you. For further information, write: Dept. PR-09 Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. **In Canada:** Linde Company, Division of Union Carbide Canada Limited, Toronto 7, Canada.

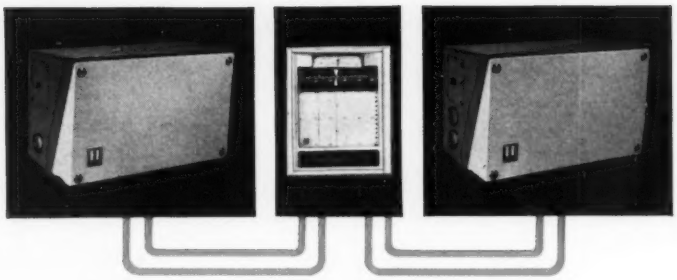
SOME AREAS WHERE MOLECULAR SIEVES IMPROVE ADSORPTION

- Purification of ethylene
- Drying gases, liquids, solvents
- Drying, sweetening natural gas
- Sweetening liquid propane, butane
- Drying jet fuels
- Octane improvement
- As refrigerant desiccant
- Controlled atmosphere purification

LINDE COMPANY

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

UNION CARBIDE



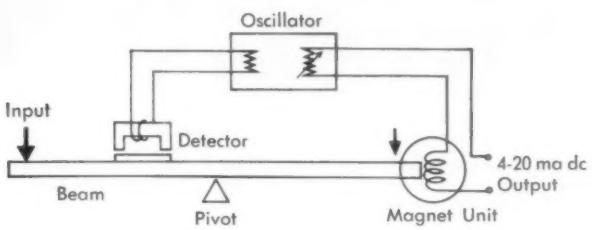
***ElectriK Tel-O-Set*—the true 2-wire system**

Care and feedback of delicate inputs

Delicate inputs thrive on the tender care of *ElectriK Tel-O-Set's force-balance feedback system*. This system, used as the basic circuit in *Tel-O-Set* transmitters, receivers, controllers, and other instruments, has proved itself in thousands of installations in the last five years. The force-balance feedback circuit increases the accuracy and dynamic response of the system by decreasing hysteresis effects and sensitivity to changes in ambient conditions.

Observe: (1) input force (from bellows, Bourdon tube, or displacement linkage) deflects pivoted beam; (2) air-gap in ferrite detector increases, (3) producing a change in inductance in oscillator circuit; (4) a portion of output current is fed back into magnet unit, producing a force on beam which is equal and opposite to input force; feedback balances beam. Full scale motion is only one-thousandth of an inch.

The advanced control engineering seen in force-balance feedback is carried through the entire *ElectriK Tel-O-Set* System. Specifically, there's no external power required at any field-mounted *Tel-O-Set* instrument. Line power connection is made only at the receiver. Two-wire d-c transmission eliminates shielding problems. The 4-20 milliamp signal range of the system gives a live zero and permits the use of the most reliable transistors available. The d-c signals



can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

Take a new look at your control applications with the *ElectriK Tel-O-Set* System in mind! Get complete technical data from your local Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, 21 Penn Street, Fall River, Massachusetts.

Honeywell

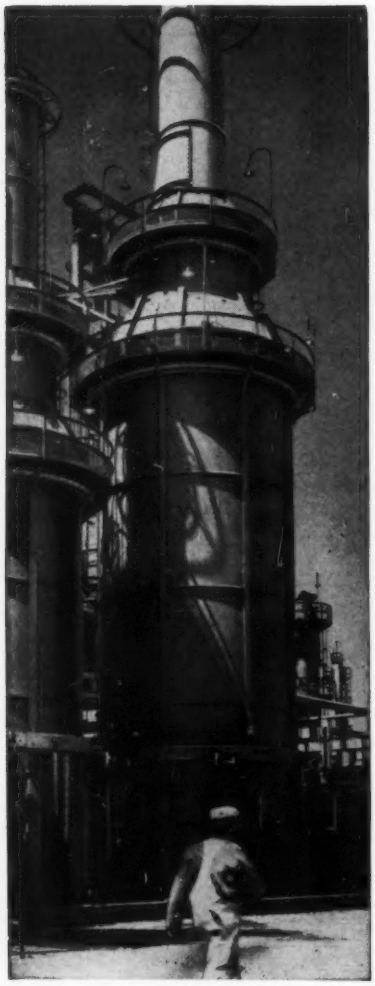
First in Control

SINCE 1885

75th YEAR

PIONEERING THE FUTURE

For more data on advertised products, use Readers' Service Cards, last page.



O_2 analysis in

13 SECONDS

with the L&N Magnetic O_2 system

Now you can detect changes in O_2 concentration in 13 seconds . . . get data to your operator before combustion gases "see daylight."

And this O_2 system does something never done before: produces a continuously averaged sample which accurately represents combustion conditions . . . and does it *day after day.*

Such reliability is bringing an entirely new concept of "on the job" stamina to flue gas sampling and measurement. Already, these O_2 systems are in operation . . . some as automatic controllers.

Write for Folder ND46-91(5), Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

LEEDS Instruments NORTHRUP Automatic Controls • Furnaces

Men . . .

national authority on catalysis and author of over 70 scientific papers, patents and books, was elected at the second International Congress on Catalysis recently concluded in Paris. He joined Houdry in 1956 and before becoming assistant director of research in early 1960, he headed the firm's organic research section. Before that he worked at Union Oil Co. and Barrett Division, Allied Chemical Co.

Bergman

Ritz

Dr. Donald J. Bergman, Fred J. Ritz and Edwin T. Steele have each completed 40 years' employment with Universal Oil Products Co. Dr. Bergman, whose present position with the company is engineering consultant, joined UOP after teaching engineering at Santa Clara University. Ritz has been superintendent of plant construction maintenance at UOP's Riverside, Ill., facility since 1937. He joined the firm as a draftsman. Steele, also a draftsman, has been in charge of drafting at Riverside since 1938.

Steele

Robert B. Sykes and Leslie T. Larson have been named projects managers, Manufacturing Department, Amoco Chemicals Corp. Larson was with the Heavy Oils Division, Standard Oil Co. (Indiana) Whiting refinery. Sykes, who joined Amoco Chemicals in December 1958, was chief engineer at American Oil Co.'s Destrehan refinery.

S. D. Breitweiser, who will remain president of DX Sunray Co., has been named president of Suntide Refining Co., Corpus Christi, Texas. **Harry A. Brown** has been elected senior vice president,

"GREAT CARE MUST BE TAKEN IN SELECTING A GASOLINE ADDITIVE"

FMC offers Dependability, Manufacturing skill, Choice of products for Gasoline Additives

Dependability – FMC protects the refiner by producing ignition control additives from basic raw materials...assuring you of optimum quality control throughout the production process, and providing you with a dependable source of supply for these products.

Manufacturing skill–FMC has a reputation for technical know-how based on more than 25 years of experience in the production of organic phosphorus compounds.

Choice of products – FMC offers you several phosphorus compounds for consideration as combustion deposit modifiers . . . will soon be in a position to supply new compounds, enabling you to choose the additive best suited to your particular conditions.

If you need a phosphorus additive to eliminate engine knock, reduce surface ignition and spark plug fouling, you can rely on the experience and facilities of FMC. Write for more information about FMC gasoline additives. We will be glad to show how these products can meet your most exacting specifications.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Chemicals & Plastics Division

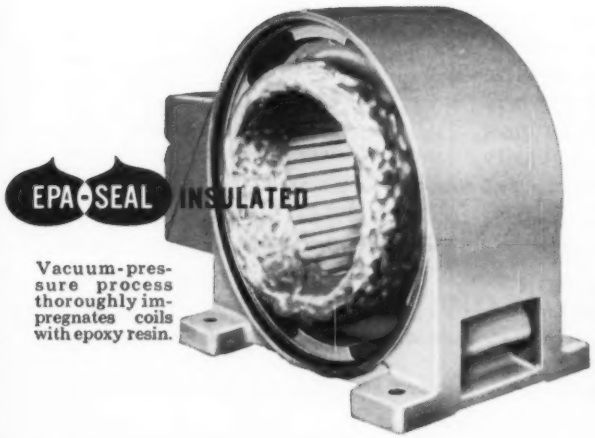
Sales Dept., 161 East 42nd Street, New York 17, N.Y.

A complete line of integral HP motors: dripproof protected—totally enclosed—and explosion proof

ELLIOTT C-W MOTORS

conservatively designed, ruggedly built, highest quality throughout

The extra service users enjoy from Elliott C-W motors is due to the conservative design, precision manufacture and high-quality materials of these machines. For most applications, the dripproof-protected type gives dependable service. Where conditions are more severe the totally-enclosed or explosion-proof construction may be required. Recently added to the line are the EPA-SEAL epoxy insulated C-W motors for service where moisture or corrosive atmospheres demand superior insulation.



Vacuum-pressure process thoroughly impregnates coils with epoxy resin.

ELLIOTT Company
Crocker-Wheeler Plant
Jeannette, Penna.

WO-2

Men . . .

Suntide Refining Co. Brown will continue as vice president, manufacturing, DX Sunray. Breitweiser and Brown are succeeding **Glenn E. Wynn** and **T. E. Fitzgerald,** who have resigned from DX Sunray to head the Sunray Chemical Co., Tulsa, Okla. Breitweiser joined Sunray in 1957 and was elected president of the company in May of this year. Brown joined the firm in 1956 as head of the Refining Division.

H. Lee Trentham has become president of the newly formed Austin Rankin Corp. The firm specializes in design, engineering and construction services to the process industries. Trentham, who received a B.S. degree in chemical engineering from North Carolina State College in 1943, was formerly vice president of engineering, Delta Engineering Corp.

Edwin J. Jennings, Jr., has been promoted to technical assistant to the general manager, manufacturing, Continental Oil Co. Formerly senior process engineer at Ponca City, he will make his new headquarters in Houston. Jennings joined Conoco at Ponca City in 1956 and was promoted to senior process engineer the following year.

Dr. H. A. Holcomb has been promoted to section head in the Baytown, Texas, Research and Development Division, Humble Oil & Refining Co.'s Humble Division. He heads the group that is engaged in chemicals development research. Dr. Holcomb holds a B. S. degree in chemical engineering from Texas Technological College and M. S. and Ph.D. degrees from The University of Texas.

Holcomb

Dr. Donald M. Beeson has joined the Chemicals Research Division, Esso Research and Engineering Co. Dr. Beeson, named head of the division's production and catalyst research section, has been with the firm ten months on a rotational assignment. He had been with Jersey Production Research Co., Tulsa, Okla., an affiliate of Standard Oil Co. (New Jersey).

Robert L. Sproull, physicist at Cornell University, has been appointed director of a government-sponsored program for the expansion of basic research in the science of materials which provides a $6,100,000 grant during the next four years. The Advanced Research Projects Agency, Department of Defense, awarded the money for the establishment of the Cornell Materials Science Center as part of a program recently initiated to stimulate research in materials science.

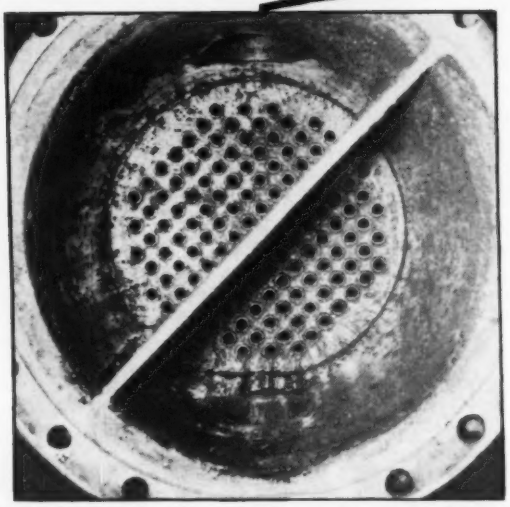
Dr. K. E. Shuler, an authority in the fields of chemical kinetics, statistical mechanics, energy transfer, and molecular spectroscopy, has been appointed consultant to the director, National Bureau of Standards. He will serve as scientific advisor to the director in connection with the bureau's efforts to strengthen its basic science program. Dr. Shuler will also continue his own research in chemical physics.

Stuart A. Milster has been named general manager, Bay Refining Co., Bay City, Mich., a division of The Dow Chemical Co. Milster has been in the Michigan petroleum business since 1947, when he joined Bay as its superintendent of distribution.

John Weir has been named division mechanical engineer in the Odessa Engineering Department, El Paso Natural Gas Products Co. He joined the products company in 1956. **Ray Garrett** has been

Positive Control for Slime and Algae!

WRIGHT'S *New* TQC*



BEFORE the application of Wrico TQC, the tubes, shown above, were nearly closed with slime. Tuberculation of the water box occurred because a slime coating prevented the corrosion inhibitor from effectively contacting the metal. Three treatments with Wrico TQC killed the slime, allowing the corrosion inhibitor to be fully effective.

Where algae is concerned, a Texas refiner said, "Our towers have always had very bad algae problems although we've tried many products. We now apply Wrico TQC weekly and have no sign of algae."

Another use for Wrico TQC is in spray programs for preserving tower wood, as it is exceptionally effective against fungal growths.

Try New Wrico TQC where you have slime, algae or fungal problems—it's positive, easily used and reasonable in cost. Write for details.

** A new development of Wright Chemical Laboratories . . . patent applied for.*

Wright CHEMICALS

WRIGHT CHEMICAL CORPORATION

GENERAL OFFICES AND LABORATORY: 615 W. LAKE ST., CHICAGO 6, ILL.

Offices in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.

RECTORSEAL #5

Means Leakproof Connections in these operations, too!

Secondary recovery, such as water-flooding and gas drive; natural gas processing; underground storage of natural gas and gas liquids, all need RECTORSEAL #5 to assure leakproof connections for the life of the installation.

Rectorseal #5, a scientific compound of ten different ingredients, meets all the requirements for leakproof connections. Slow drying and soft setting, it never hardens, never seizes threads . . . withstands pressures to 11,500 psi. . . . is easy to apply, economical to use.

Get Rectorseal #5 from your oil field supply store, industrial distributor, or write for test sample.

RECTORSEAL—Dept. R

2215 Commerce St., Houston 2, Texas

RECTORSEAL #5
THE POSITIVE LEAK PREVENTER

Babbitt *Adjustable* **SPROCKET RIM**
with Chain Guide
CHANGES THAT DANGER ZONE TO A SAFETY ZONE

—enables you to ADD PLANT AREA

If re-aligning equipment will yield more working space, better production, lower costs—do it NOW. Save all space wasted for placing ladders to reach overhead valves. At the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman, or contact us direct.

Babbitt STEAM SPECIALTY CO.
6 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

---

2 NEW
RIDGID
CHAIN
WRENCHES
No. C-14 for up to 2" Pipe and Fittings
No. C-18 for up to 2½" Pipe and Fittings
give real Action-Grip in Tightest Places

Work on Round, Square or Irregular Shapes Other Wrenches Can't Reach!

In extra close quarters, there's nothing that'll beat these new RIDGID Chain Wrenches for getting the job done. Fast, ratchet-like action in either direction . . . from either side. Give tight grip without crushing. Large, easy-to-grab end ring for fast chain adjustment. Tempered steel chain locks securely . . . releases quickly. Rugged, comfort-grip, I-beam handle, guaranteed not to break or warp . . . handy hang-up hole.

Light and easy to use, these new RIDGID Chain Wrenches do everything a regular wrench can do . . . and much more. Call your Supply House and get one today!

RIDGID
The Ridge Tool Company • Elyria, Ohio, U.S.A.

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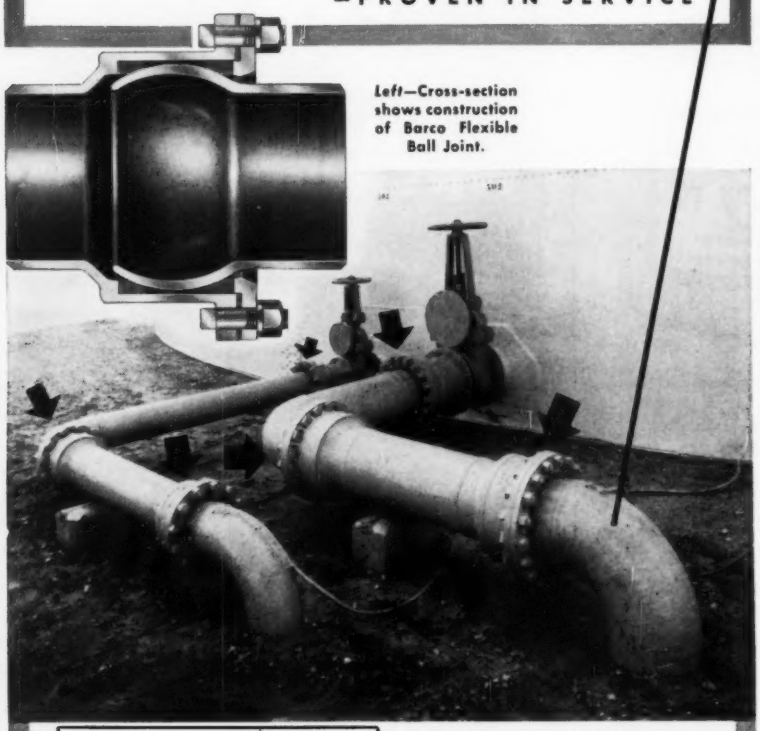
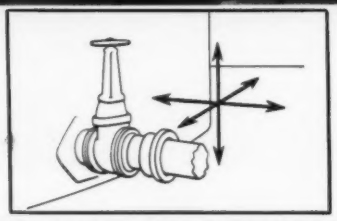
Unlimited Flexibility!

—PROVEN IN SERVICE



Left—Cross-section shows construction of Barco Flexible Ball Joint.



Allows 6-Way Movement!

Freedom of movement in any direction is readily possible with these *ball joint connections* of 12" pipe (right) and 8" pipe (left) to 80,203 bbl. tank shown in above photo. (Photo: SHELL OIL COMPANY, Dominguez Refinery, Wilmington, Calif.)

Barco Ball Joints—*Fire Safe!*

provide complete protection against FIRE, PIPE EXPANSION, TANK SETTLING

Major oil companies throughout the country now approve the use of Barco's new large size Flexible Ball Joints on tank connections for the following reasons:

1. **Fire-safe. The joints have passed rigid fire and water spray tests.**
2. **Superior for handling pipe expansion—no combustible packing, no thin wall sections, no "end thrust" from pressure, no heavy pipe anchoring required.**
3. **Complete protection—relieve strain and twisting forces on valve flanges or tank wall.**
4. **Compact! Ideal for use inside narrow space between fire wall and tank. Easy to design piping for any amount of flexibility desired.**
5. **Also useful for insulating piping against electrolysis.**
6. **Long service life without maintenance. No lubrication. Sizes to 16"; flanged or welding ends.**

For engineering recommendations, see your nearest Barco representative or write. ASK FOR CATALOG 215B and BULLETIN 31-A.

PRODUCTS BACKED BY EXPERIENCE BARCO FOUNDED 1908

BARCO MANUFACTURING CO.

542K Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

In Canada: The Holden Co., Ltd., Montreal

Men . . .

appointed division chemical engineer. Garrett also joined El Paso Natural Gas in 1956. **Mark Foerster** has been promoted from electrical engineer to division electrical engineer.

G. F. Bassler, Houston, has been promoted to assistant to the general manager of manufacturing, Continental Oil Co. (Panama operations). Formerly director of personnel development, Bassler will continue to make his headquarters in Houston. He will assist **D. R. Johnson** and the management of Refineria Panama, S. A., on personnel and industrial relations matters. Before joining Conoco in 1955, he served two years as management development supervisor for The Murray Corp., Detroit, and five years as senior training supervisor for Creole Petroleum Corp. in Venezuela. He received his bachelor's degree in industrial education in 1939 from Stout Institute, Menomonie, Wis., and did graduate work in industrial education at the University of Tennessee and Ohio State University.

Bassler

Osgood V. Tracy, formerly president of Esso Standard, Division of Humble Oil & Refining Co., has been elected a director and an executive vice president, W. R. Grace & Co. Tracy will fill the post held by **Marlin G. Geiger** who died May 13, 1960. He will be in charge of the company's chemical business, seven operating divisions and the Research Division.

Dr. Philip S. Nisson has been promoted to manager of the Technical Department, Pure Oil Co.'s Refining Division. He succeeds **Adolph Spiehler** who is remaining with the company in an advisory capacity. Dr. Nisson, a graduate of Harvard College and holder of a Ph.D. in organic chemistry from Columbia University, joined Pure in 1933 as a resident chemist at the Muskogee, Okla., refinery.

Robert J. Collins, along with **Ronald G. Graham** and **Robert J. Macur,** has been appointed engineer in the Manufacturing Department, Amoco Chemicals Corp. Collins, Graham and Macur were previously employed in the General Engineering Department, Standard Oil Co. (Indiana) at Whiting. Collins graduated

WE POUR 40 YEARS' EXPERIENCE INTO EVERY GLASCOTE VESSEL

Behind every Glascote glass-lined product is an experienced sales engineer who can give you on-the-spot product and process assistance. And behind him, there are 40 years of Glascote experience in manufacturing glass-lined vessels and tanks for the petroleum and chemical industries.

Through continuous research and development engineering, Glascote stays ahead of the demand for new and improved processes requiring a wider range of corrosion, temperature and thermal shock-resisting properties for glass linings. For example, new Glascote 778 is the most corrosion-resistant glass ever applied to chemical and petroleum processing equipment — this without sacrificing any other protective property.

Glascote and its parent organization, A. O. Smith Corporation, have developed more than 3000 glass formulas — the best of these giving you superiority in glass-lined reactors, columns, storage tanks, rotary dryer-blenders, pipe and fittings. For additional information, ask your Glascote representative for specific product data. Or write direct: Glascote Products, Inc., Cleveland 17, Ohio.

Through research A.O. Smith *... a better way*

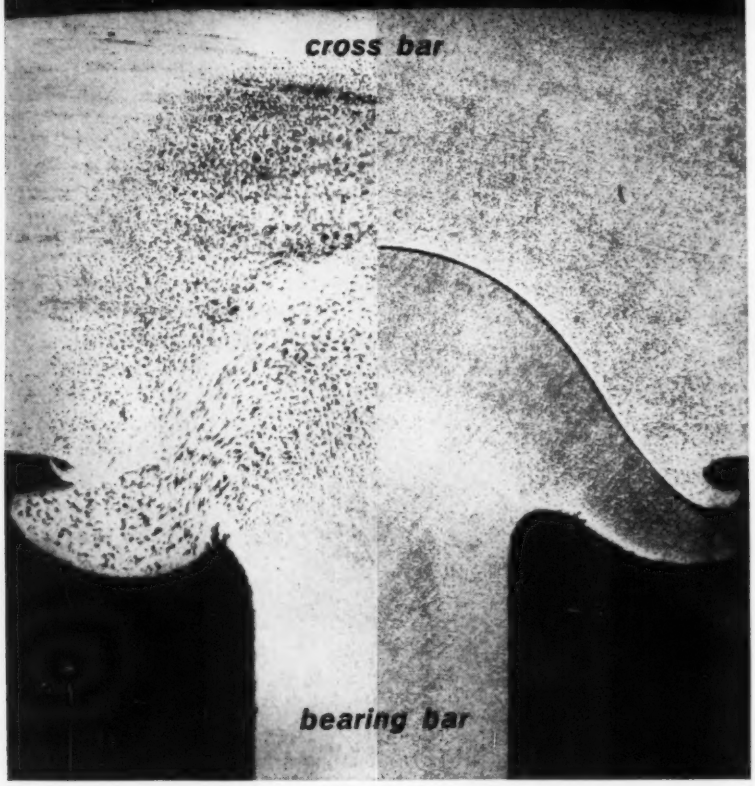
A.O.Smith
CORPORATION

Subsidiary: GLASCOTE PRODUCTS, INC.

REACTORS · SPHERICAL REACTORS · COLUMNS · STORAGE TANKS · HEAT EXCHANGER TUBES · ROTARY DRYER-BLENDERS · PIPE AND FITTINGS

For more data on advertised products, use Readers' Service Cards, last page.

this or this



This is Dravo Tru-Weld Grating. In this cross section of a cross bar-bearing bar weld, the metal has fused together. There are no gaps to admit moisture or weaken the joint. It cannot come apart.

Here fusion of metals is incomplete. There is a noticeable gap between bearing bar and cross bar, an open invitation to internal corrosion which can weaken the joint and add to maintenance costs.

which weld for your grating?

Tru-Weld grating is stronger because it is *made* that way. Its added strength comes from a manufacturing process that completely fuses the metal at cross bar-bearing bar joints and holds the bars to exact spacing. The result is grating that stands up under excessive vibration, heavy traffic or in areas where corrosive fumes and moisture are a problem. And Dravo Tru-Weld grating *costs no more.*

Complete estimating, layout and fabricating services are available. Immediate delivery from stocks maintained at nearby Joseph T. Ryerson Service Centers will help you meet exacting construction schedules.

For more information on this new, stronger grating, call the Dravo representative in your area, or write DRAVO CORPORATION, PITTSBURGH 25, PA.

DRAVO
CORPORATION

Men . . .

from Michigan College of Mining and Technology in 1956; Graham received a B.S. degree from the University of Missouri in 1954, and Macur got his bachelor's degree from the Illinois Institute of Technology in 1951.

J. A. Smith, superintendent of gas and gasoline plants, Los Angeles Division, Texaco, Inc., has been elected president of the California Natural Gasoline Association. **K. C. Vaughan,** Union Oil Co. of California, is the outgoing president. Smith joined Texaco in 1926 after attending the University of Colorado. He was appointed assistant to the superintendent of the company's gas and gasoline plants in 1938, and was promoted to his present position in January 1958.

Smith

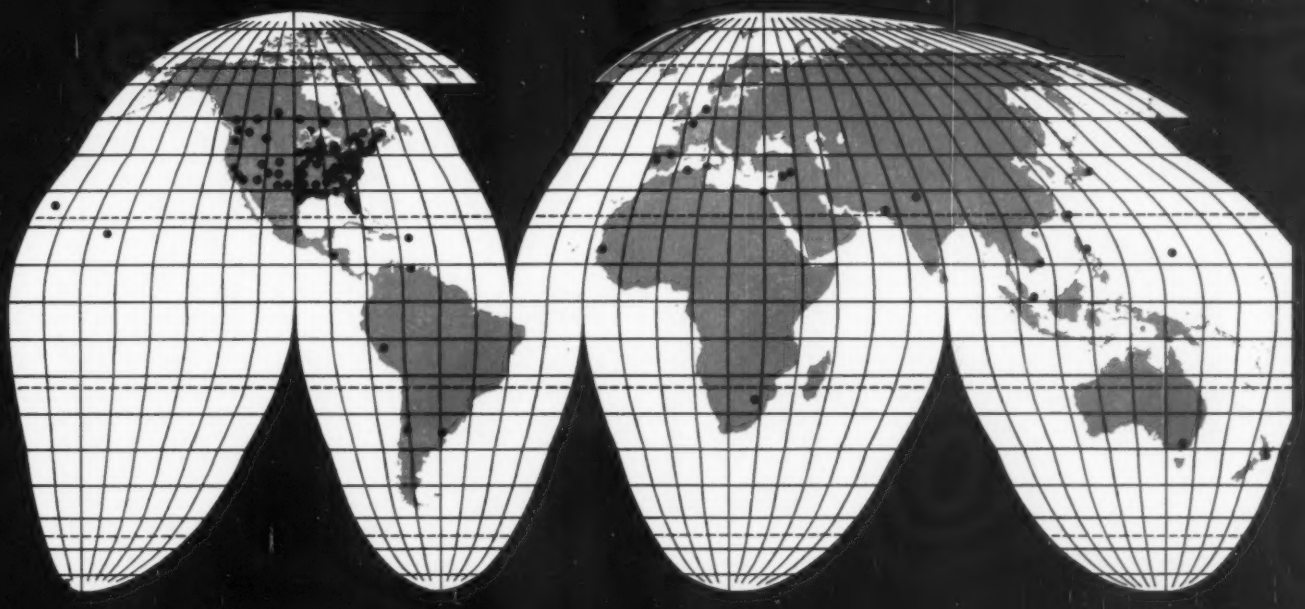
Paul E. Schmidt has been named a section leader at the Whiting research laboratories, Standard Oil Co. (Indiana). He will direct work on evaluating new plastics. **Richard J. Ross** has been appointed a group leader, and **Richard E Van Strien,** who has been named a section leader at the laboratories, will direct work on testing and evaluating new chemical raw materials, derived from petroleum, for use in the paint and plastics industries.

J. Ming Chew has rejoined the Technical Division, Humble Oil & Refining Co.'s Baytown refinery, and is working in the aviation section. He has served as an officer in the U. S. Navy for the past three years. Chew holds a B.S. degree in chemical engineering from Georgia Institute of Technology.

Frederick G. Wilmot has been appointed manager, contract development, Mannix Co., Ltd., a Canadian heavy construction firm, with offices in Calgary, Alta. Wilmot will specialize particularly in the area of the petroleum industry where he has had broad experience.

R. T. Kelley has been named head of the manufacturing coordination section, Enjay Chemical Co. Kelley, who replaces **T. H. Rhodes,** holds a B.S. degree in chemical engineering from Rose Polytechnic Institute and a master's degree from Carnegia Tech. He joined the company in 1950, and headed a butyl techni-

For more data on advertised products, use Readers' Service Cards, last page.



There's a world of service available

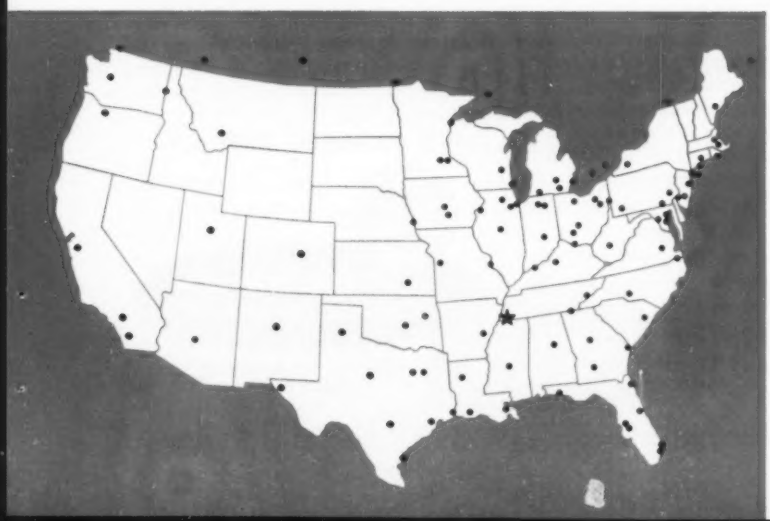
when you specify *LAYNE*

PUMPS • WATER WELLS • WATER TREATMENT

Any service is only as good as its availability when you need it.

Layne service for *any* pumps, wells, water systems and water treatment for Industry—Municipalities—Agriculture is available throughout the world, 24 hours a day. The vast network of Layne Associate Companies with over 75 years' experience, trained personnel and quality Layne replacement parts, assure prompt and complete service wherever you may be located. Industrial Sales Representatives in major cities. Write for Layne Service Bulletin 100.

Layne complete water services include: initial surveys • explorations • recommendations • site selection • foundation and soil sampling • well drilling • well casing and screen • pump design, manufacture and installation • construction of water systems • maintenance and service • chemical treatment of water wells • water treatment • all backed by Layne Research.



Layne SINCE 1882 — WORLD'S LARGEST WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

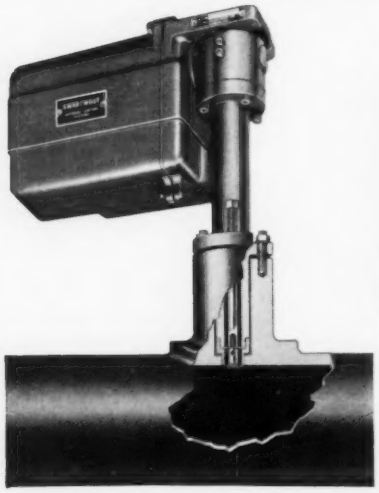
GENERAL OFFICES AND FACTORY, MEMPHIS 8, TENN.

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Sales Representatives in Major Cities

Great things are happening in AutroniC® Control

TOUGH PROBLEMS ARE NO PROBLEM



FOR THIS FOOLPROOF, FOUL-PROOF PRESSURE TRANSMITTER

Here is a primary sensing element for those tough jobs you'd like to forget. Mounted right on the process pipeline or tank, the Swartwout Flush Diaphragm Pressure Transmitter will effortlessly measure pressure or liquid level of polymers, slurries, asphalts, viscous fluids, molten metals and other difficult media. No stagnant pressure lines, no steam jacketing necessary . . . the stainless steel transmitter diaphragm fits flush with the inside of the vessel.

A friction-free linkage multiplies diaphragm motion and actuates the core of a differential transformer to produce a 0-0.5V AC signal for any Swartwout AutroniC indicator, recorder or controller. Sensitivity is better than 0.005%, reproducibility 0.1%, accuracy 1.0%.

The Flush Diaphragm Pressure Transmitter is just one unit in the constantly-growing AutroniC family of electronic instrumentation . . . a family that includes all necessary components for complete electronic control of any process parameter.

For details on the Flush Diaphragm Pressure Transmitter, request Bulletins A-713 and A-718. Swartwout Division, Crane Co., Hooksett Industrial Park, Manchester, N.H.

SWARTWOUT

. . . world leader in electronic process instrumentation

S.A. 1958

Men . . .

cal group at the Baton Rouge refinery. **D. H. McClure** has been appointed manufacturing coordinator for Enjay Chemical. He was in design work in chemical technical service at the Baton Rouge refinery.

Coombs

Steinhoff

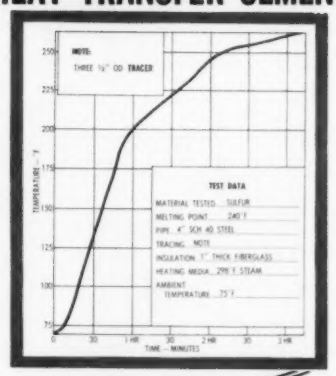
Houlgrave

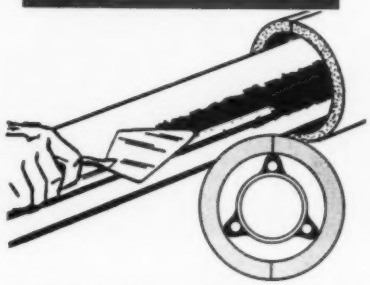
Standefer

G. G. Coombs, mechanical superintendent, has been transferred from American Oil Co.'s Texas City refinery to American Oil's Yorktown, Va., refinery. Coombs joined the company in 1925 at Baltimore, Md. He was transferred to Texas City in 1933. **R. C. Steinhoff, Jr.,** operating superintendent, succeeds Coombs as mechanical superintendent at Texas City. Steinhoff joined the firm in 1942 as an apprentice engineer. **C. J. Houlgrave,** chief refinery engineer, takes Steinhoff's place as operating superintendent. Houlgrave came to American Oil after graduating from Tulane University in 1935. **W. R. Standefer, Jr.,** assistant mechanical superintendent, has been promoted to chief refinery engineer. Standefer joined the refinery's Mechanical Department in 1940. **P. A. Stewart** transfers from the Yorktown refinery to Texas City to replace Standefer as assistant mechanical superintendent.

Stewart

Sulphur Handling is No Problem with THERMON HEAT TRANSFER CEMENT





An increasing number of plants are using Thermon Heat Transfer Cement to eliminate sulphur handling problems encountered with internal tracing and steam jacketing. A non-metallic adhesive compound with highly efficient heat transfer properties, Thermon Heat Transfer Cement in sulphur installations

Eliminates misfitting of prefabricated pipe
Eliminates possibility of cross contamination
Eliminates need for stuffing boxes and packing glands
Reduces cost of installation by *at least one-half*
Reduces maintenance costs

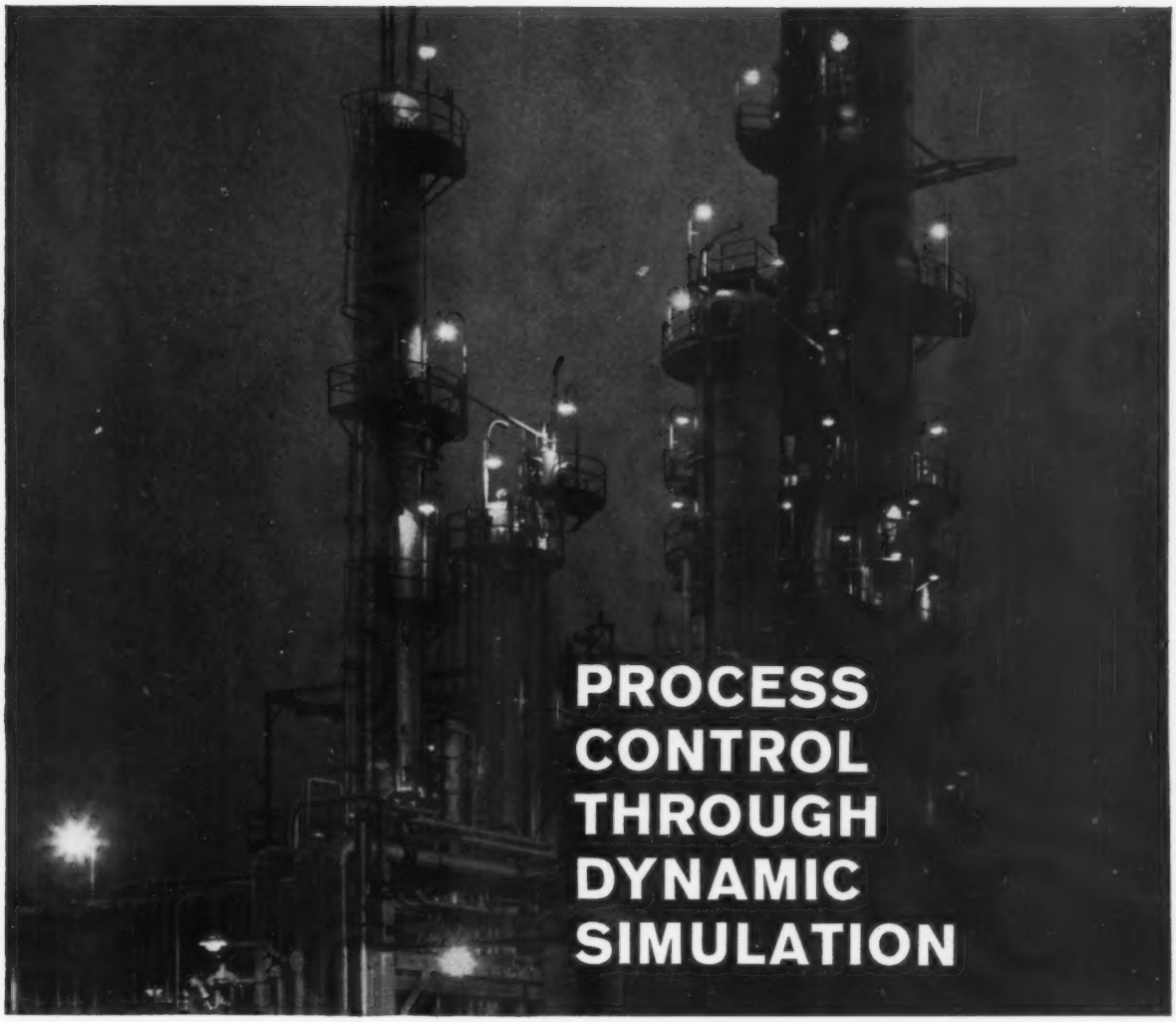
Thermon has been used successfully on pumps, valves and pilot plant and other equipment in sulphur service. Investigate the problem-solving and money-saving properties of Thermon, the *proved* solution to heat transfer problems.

Write for Thermon Bulletin 300.

THERMON
THERMON MANUFACTURING CO.

1017 Rosine • P. O. Box 1961
Houston, Texas

119



a new approach to process computer control

Through **dynamic simulation**, Link offers you process computer control that . . .

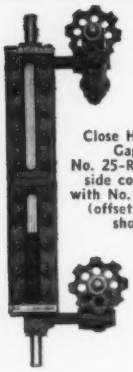
- **permits** dynamic study of transients during process upsets or load changes.
- **operates** on inputs/outputs familiar to process engineers and operators.
- **provides** a convenient engineering tool for studying operating procedures and process revisions.
- **is designed** to represent complete process needs without simplifying process or providing excess computer capacity.
- **can be** installed with minimum revision to existing instrumentation.
- **utilizes** standard analog and digital building blocks functionally grouped to permit installation in stages.
- **allows** integration with other processes to increase the scope of computer control.

If you are looking for maximum return on a minimum capital investment, consider Link **dynamic simulation** for your computer process control. For specific details—or an engineering presentation—contact J. C. Croft, Manager, Industrial Control Products.

LINK DIVISION
Binghamton, New York

Another example of Link / Ability
GENERAL PRECISION, INC.
Other Divisions: GPL, Kearfott, Librascope.

For more data on advertised products, use Readers' Service Cards, last page.



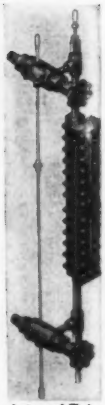
Close Hook-Up Gages. No. 25-R-20 gage, side connected with No. 66 valves (offset inside) shown.

Magnetic Gage. Safety sealed.

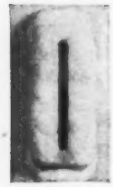
Welding Pad Gages, staggered for continuous visibility

No. 66UVG Instrument Piping Valve, with vertical rising ball check

No. 93 Valve (Jacketed for Heating or Cooling)



Internal Tube Model Heated-Cooled Gage, Reflex Type



Patented Non-Frosting Gage

EPL-56 Illuminator, UL and CSA Approved, for use on all Jerguson Gages

At Jerguson you get a complete line of

LIQUID LEVEL GAGES, VALVES and SPECIALTIES

For Chemical and Petrochemical Processing

Jerguson works closely with the men in the chemical and petrochemical industries and has developed a complete line of specialized gages, valves and other equipment to meet your problems of observation of liquids and levels. All types of gages and valves are available in stainless, monel, nickel, hastelloy and many other materials . . . also with rubber, neoprene, lead, teflon, Kel-F and other linings. Gages are made in a variety of connections . . . end, side or back . . . for close hook-ups to meet your needs.

New Magnetic Gage. For use under conditions where glass, gaskets and threads cannot be used.

Close Hook-Up Gages. Made in Reflex or Transparent types with a variety of offset valves for several close hook-up installations.

Large Chamber Gages. Minimize boiling and surging effect. Made in both Reflex and Transparent; also with non-frosting gage glass extension.

Welding Pad Gages. For use where gage must be integral part of vessel. Also made in circular sight glass model.

Group "G" Instrument Piping Valves. Give tremendous time and cost savings. Unions, nipples, reducers, elbows, tees, valve and bleed valve all combined in space saving unit, greatly reducing number of connections.

Heated and Cooled Gages and Valves. Complete line of heated and cooled gages and valves, in various models, both Reflex and Transparent.

Non-Frosting Gages. (Patented Flat Glass model, Reflex type, illustrated.) Effective frost preventing gages in both internal and external tube models.

Write for Data on Jerguson Products for Chemical and Petrochemical Processing.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

Representatives in Major Cities
Phone Listed Under JERGUSON

JERGUSON GAGE & VALVE COMPANY

100 Adams Street • Burlington, Mass.

Jerguson Tress Gage & Valve Co., Ltd., London, Eng., Pétrole Service, Paris, France

Men . . .

Dr. Franc A. Landee has been advanced to research scientist, The Dow Chemical Co. Dr. Landee will continue to pursue research on several projects including the indexing of scientific literature and its filing and retrieval from magnetic tape and other long-range problems of computer usage in research. He joined Dow in 1935 as a chemist in the main laboratory. He has been a chemist in the physical research laboratory, a process engineer and head of laboratories at the Los Angeles styrene plant, and a research supervisor, Dow Western Division, Pittsburg.

Landee

Walter F. Baleiko, M.D., has joined Standard Oil Co. (Indiana) as staff physician in the general office Medical Department. He was formerly with the Crane Co. He graduated from Loyola University School of Medicine. He is a member of the American Medical Association and Illinois and Chicago Medical Societies.

W. T. Hughes, Jr., secretary, California Texas Oil Corp., has been appointed associate general counsel. Hughes, who will continue to serve as corporate secretary, received his law degree from Harvard University in 1939.

Irwin S. Schwimmer, a member of American Gas Association's Bureau of Statistics staff for 12 years, has been appointed assistant director of the bureau. He also will become the bureau's rate specialist. Schwimmer joined A.G.A. as a junior statistician in 1948 after serving a year with the National Industrial Conference Board, New York. He graduated from New York University's School of Commerce.

Dr. Edward P. King has been promoted to assistant manager, Operating Department, Pure Oil Co.'s Refining Division. Dr. King joined Pure in 1936 in the company's research laboratory, Northfield, Ill. He received his doctor's degree in chemical engineering from the University of Illinois. His undergraduate work was completed at Eureka College, Eureka, Ill.

R. N. French has been promoted to staff engineer, Technical Division, Humble Oil & Refining Co.'s Baytown refinery. He coordinates the mechanical, civil and instrument engineering on

6 FOR THE 60's

Six Worthington centrifugal pump lines selected by Worthington Technical Representatives as giving the most value to their customers.

WORTHINGTON

6 for the 60's Pump Information Guide

The ideal product combination of economical design and efficient performance requires programs in many areas—Research, Engineering, Manufacturing—are only a few. Knowledge gained by Worthington in these areas is used to improve pump design and is made available to pump users as well.

Worthington projects making this knowledge available have taken many forms. For example:

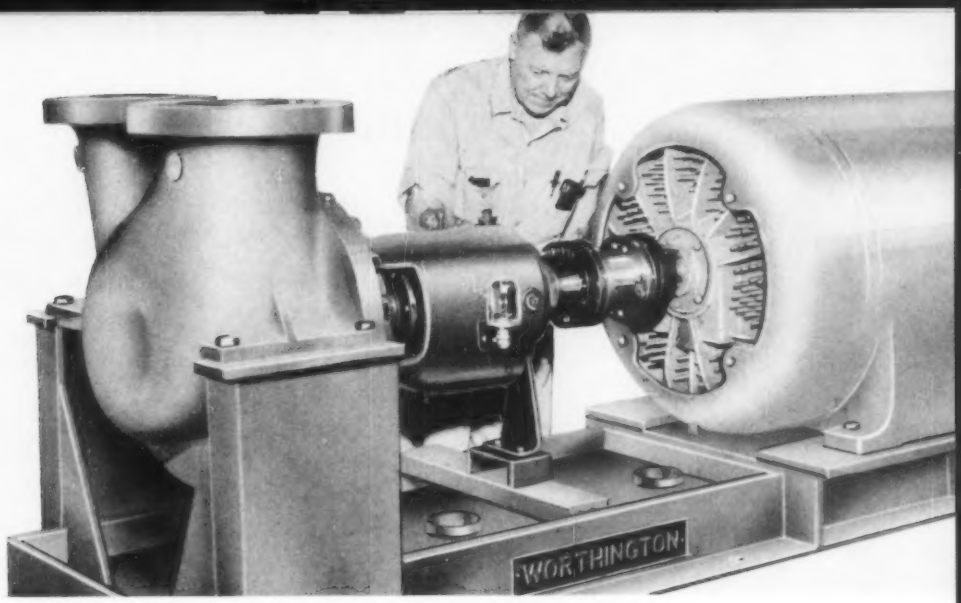
Technical Pump Seminars—currently being conducted with customers throughout the country.

The Centrifugal Pump Clinic—presented in the form of questions and answers in the interests of better pump operation.

Reprints of Technical Articles—detailed discussions of pump application and design topics. Two typical releases are "An experimental investigation of radial thrust in centrifugal pumps" (RP-1087) and "Cavitation and NPSH" (RP-1094). These two papers represent extensive research at Worthington's Harrison, New Jersey Research Laboratory.

Your Worthington Technical Representative will be glad to discuss your pumping problems and provide information on the above programs—call him at your local Worthington District office.

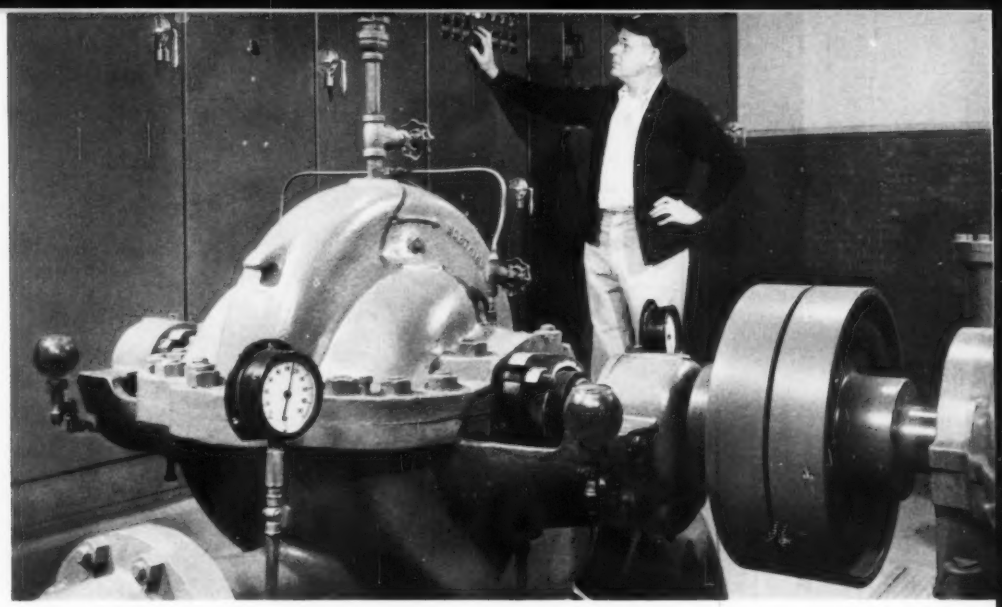
HN



MOST ECONOMICAL FOR PROCESS JOBS—REQUIRE LESS NPSH

Worthington HN pumps offer remarkably low NPSH requirements. Construction features are outstanding, too. For example, the positive ring oil lubrication system and bearing housing protected against contamination assure long trouble-free service. And the large diameter cantilever shaft assures negligible deflection, thus prolonging wearing ring, seal or packing and sleeve life. Built for flexibility and interchangeability, HN pumps handle temperatures to 850F and pressures to 600 psi.

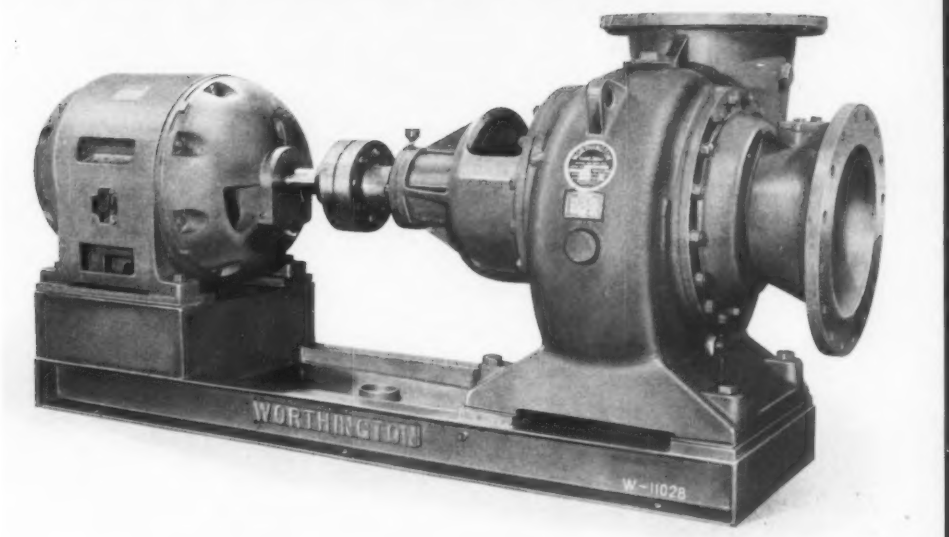
LN



"DOUBLE VOLUTE" DESIGN IS RADIALLY BALANCED AT ANY LOAD

These general purpose pumps use a casing design that gives hydraulic balance at any capacity. This design, called "Double Volute," makes pump operation possible from design point back to shut-off without adverse effects of hydraulic radial reaction. "Double Volute" design reduces wear and makes an LN pump one of the most reliable you can buy. And just as important, the LN design includes many other up-to-date features for economical installation and operation.

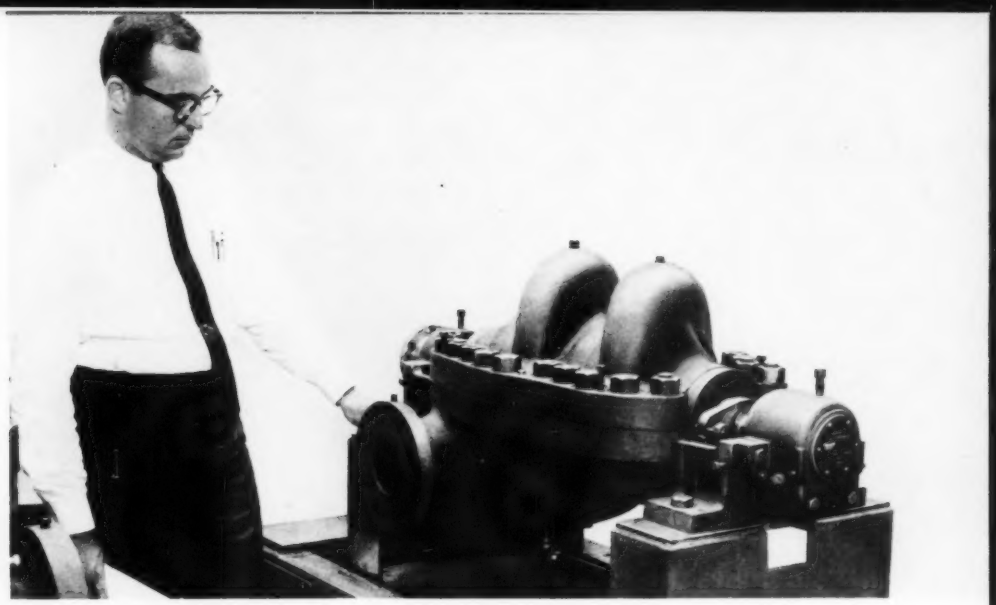
MC



HIGH CAPACITY AT LOW HEADS—WITHOUT CLOGGING

Type MC is the Worthington Mixflo pump—proven for irrigation, drainage, waste disposal, condenser circulating and low-head water supply. Non-clogging sewage type closed impellers pass large solids. There are variations in construction to suit any installation: bronze or chrome steel wearing rings; bronze or chrome steel shaft sleeve; vertical bottom suction models, discharge in any direction too. Sizes 10″ to 84″.

UN



A RUGGED, HEAVY-DUTY PUMP AT A COMPETITIVE PRICE

Any reputable manufacturer can build a pump that will outlast anything on the market. The trick is to do it at a competitive price, with proven design features. This dual ideal has been accomplished with Worthington's UNB and UNQ pumps through a planned program of standardized parts and simplified manufacturing techniques. Typical of the outstanding design features is the elastic seal ring that prolongs casing life by eliminating interstage leakage.

KB

AN ELBOW PUMP WITH APPLICATION AND INSTALLATION FLEXIBILITY

Worthington's KB elbow pumps have been designed to provide an economical combination of operating efficiency and NPSH requirements. The construction lends itself to installation in place of an elbow in a circulating system. Designed with top suction to reduce installation cost. KB elbow pumps are supplied in Type 300 stainless steels and Worthite—Worthington's super stainless.

SE-
SC

STANDARDIZATION TO CUT INVENTORY AND MAINTENANCE

This Worthington Standard End Suction Centrifugal line takes care of about 70% of all centrifugal pump requirements, as proven by sales records showing basic types of pumps purchased. Ratings range up to 2700 GPM and 230 ft. head. In each of 120 pump ratings, there's a variety of materials of construction, types of liquid ends, shaft sealing methods and drives. There are literally 70,480 combinations to choose from—but the extreme standardization can cut warehousing and inventory costs as much as 50% and reduce maintenance.

SIX CENTRIFUGAL PUMPS VOTED "BEST VALUE" FOR THE 60's

"Every salesman has his favorite product." And so do Worthington Technical Representatives. By vote they picked the six centrifugal pumps that were their "favorites"—preferred because they felt these Worthington pumps give you the most value for your pump dollar.

Remember, this value rating has been awarded by Worthington Technical Representatives on the basis of their observations of your operating needs. See the booklet below for a summary of the features that make each of these six pumps your best buy.

P.S. In an election like this some had to lose. Actually, picking the winners was tough . . . the Worthington pump line covers virtually every pumping job well. Tell us your problem . . . we'll gladly give you a recommendation based on an unbiased complete line selection.

WORTHINGTON

"6 for the 60's" Pump Information Aids

WORTHINGTON CORPORATION
Section 21-5
Harrison, New Jersey

Please send me application and performance data on the lines checked below:

HN_____ MC_____ KB_____

LN_____ UN_____ SESC_____

NAME_____

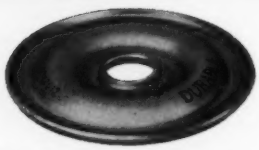
COMPANY_____

STREET_____

CITY_____ STATE_____

Pencil test demonstrates how the DURABLA valve member tilts and opens easily, without noticeable friction. Compare this with any other pump valve.

NO. 1 REASON



this is the ideal valve for high-speed pumps

Key to the high efficiency and free action of a DURABLA V-7* Pump Valve Unit is the patented lightweight valve member. Making only "point contact" on the sleeve, it can't bind or hang up. Nor can it warp, thanks to its unique arched design.

This low-lift valve member is designed to open with a tilt, following the flow lines. Valve action is very sharp, thanks to lightness and flexibility. That's why DURABLA is the only valve ideally suited to high-speed operation.

DURABLA valve units operate freely under temperature-pressure extremes, with corrosive fluids and in any position. Available in 17 sizes, they will meet over 300 variations in installation requirements.

Send for booklet PE90

DURABLA MANUFACTURING COMPANY

114 Liberty Street, New York 6, N. Y.

DM-35

*Patent applied for

DURABLA®

Manufacturers of DURABLA sheet packing, gaskets and check valves

Men . . .

major additions, and maintenance engineering on existing facilities at one of the light ends units. French holds a B.S. degree in mechanical engineering from Louisiana State University.

H. B. Brown has been elected an administrative vice president of Gulf Oil Corp. and appointed coordinator, transportation. With Gulf 10 years, Brown succeeds **R. D. McGranahan,** who recently resigned to become president of Wilshire Oil Co. Brown graduated from Williams College, Williamstown, Mass. He started his business career with the Allison Division, General Motors Corp. in September 1939. In 1950, he joined Gulf as a member of the Executive Department, general office, Pittsburgh.

Brown

Dr. Edgar L. Steele has accepted an assignment in the Analytical Chemistry Division, Esso Research Engineering Co., Linden, N. J. Before starting his new job, Dr. Steele will take a year of post graduate work at Michigan State College. He has been on the technical staff, Esso Research Laboratories, Baton Rouge refinery, Esso Standard, Humble Oil and Refining Co., for the past two years.

E. H. Hermsen, Los Angeles, has been elected corporate secretary, Tidewater Oil Co., succeeding **W. J. Burker.** Hermsen has been assistant corporate secretary for Tidewater in the firm's Los Angeles home office since 1955, and previously served as an attorney in the firm's Legal Department. Prior to joining Tidewater in 1945, Hermsen practiced law in Oconto, Wis.

Dr. Andrew Dravnieks has been named scientific advisor in chemistry research, Armour Research Foundation. Dravnieks came to the foundation from Standard Oil Co. (Indiana) where he headed the corrosion section. Dravnieks is a native of Latvia and received a chemical engineering degree from the University of Latvia. He received his Ph.D. from Illinois Institute of Technology in 1949.

L. N. Anderson has been promoted to assistant superintendent of the Western district, Natural Gasoline Department, Phillips Petroleum Co., Odessa, Texas. Anderson, who started with Phillips in 1941, graduated from the University of

For more data on advertised products, use Readers' Service Cards, last page.

CENTRIFUGAL COMPRESSORS

DE LAVAL welded impeller permits higher horsepower, higher tip speeds, greater design flexibility

Now, with a single welded wheel, compressors rated up to 20,000 horsepower at 6500 rpm are giving excellent service.

Produced by a special welding process developed by De Laval, this new welded wheel construction permits higher tip speeds and fewer stages for a given pressure ratio.

Write for more information on this new welded impeller or contact your local De Laval representative.

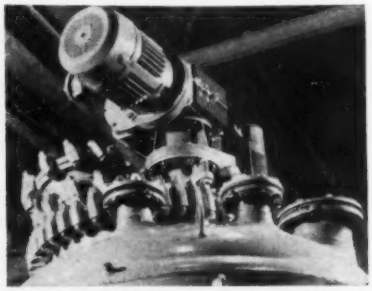
Shown above are two De Laval barrel type compressors—driven by De Laval turbines—in a typical large refinery installation. Units like these are used to pump heavy and light gases and for supplying combustion air for cat crackers.

DE LAVAL STEAM TURBINE COMPANY
811 NOTTINGHAM WAY, TRENTON 2, N. J.

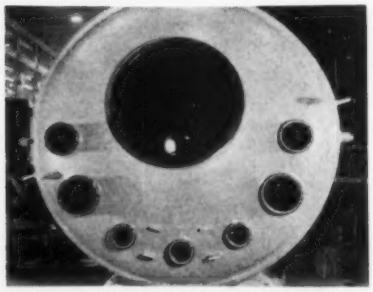
DL-480 A

FLUIDICS* AT WORK

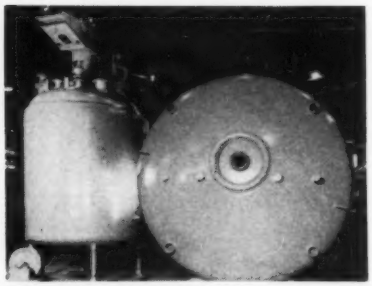
Different silhouette and light-blue exterior tell you the Pfaudler "RA" Series Glasteel Reactor is new. Unit shown has BH drive.



TW drive, one of two new drives, provides increased stability for agitator shaft. Runs very quietly.



"Mirror image" provides like-size nozzles on each half of top head. Facilitates piping.



Offset bottom head outlet is in sweep path of agitator and in line with top head manhole.

NEW from top to bottom . . . Pfaudler "RA" Series Reactors

The old "Pfaudlers" (R Series) that you're so familiar with are passing from the scene.

In their place, we now offer you the all new "RA" Series Glasteel Reactors with many significant design improvements.

Two new drives. Starting at the top you'll find the TW drive on the 300 through 1000 gallon reactors for power requirements to 15 H.P. The BH drive takes over on the 1500 gallon and larger sizes for power requirements to 60 H.P.

Both drive designs are compact, easily installed and maintained. Very quiet, too—a difference that's appreciated when operating a full line of reactors.

Mirror image top head. Next, note the equal number of nozzles on each half of the top head, placed symmetrically for ample freedom in piping. For example, you can feed two reactors from a single tee—one to the left, one to the right.

And since there are no cumbersome drive supports, you have convenient access to manhole, observation window, nozzles, drives, baffles, dip pipe and mechanical seal.

Offset drain. Off the bottom head you get fast drainage, since the outlet has been offset from center to a position in the direct sweep path of the agitator. Also, the outlet is in line with the top head manhole for convenient inspection.

Corrosion resistance. Of course, inside there's Glasteel 59. Excellent resistance to all acids (except HF) to 350° F. and on to 450° F., depending on concentration. Mild alkalies at moderate temperatures are also permissible. Thermal shock resistance is 30% over the "R" series. At a vessel temperature of 250° F. your recommended safe temperature differential is now 260° F. Abrasion resistance has also been increased by 20%. Glasteel 59 is smooth—resists build-up of sticky products. As a result, you have high heat-transfer rates, increased product yield, fewer shutdowns for cleaning, and much longer service life.

Stock delivery. Standard "RA" Series Reactors range in size from 300 to 4000 gallons. The 500, 750, 1000 and 2000 gallon vessels, fully assembled with standard drives and agitation, are pre-stocked for *two-week* delivery from receipt of your order.

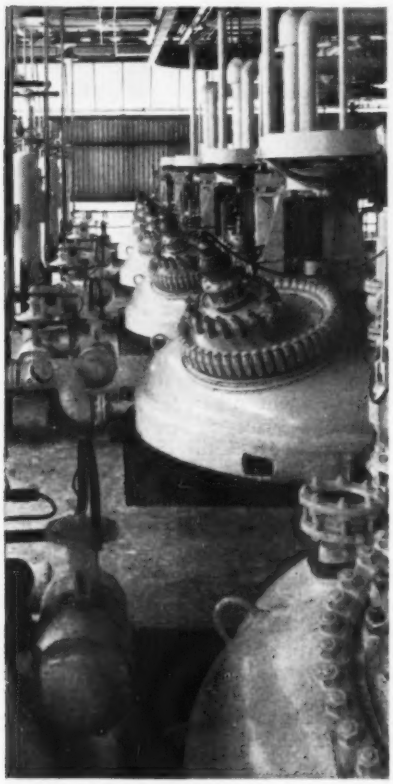
Write for specifications. New Bulletin No. 988 is now available.

How to test the value of Glasteel polymerizers

Consider three important factors—purity of the polymer, amount of downtime, and initial cost. Then look at what you can expect from Pfaudler Glasteel polymerizers.

Product purity. Glasteel will not contaminate or discolor materials you use in making synthetic resins. Nor will it act as a catalyst to set off undesired side reactions.

Naturally, you also get Glasteel's unmatched acid-alkali corrosion resistance so you can project a long service life for this equipment.



Reduced downtime. Glasteel has an abrasion-resistant, smooth surface—smoother than the most highly polished metals. So even sticky substances don't adhere readily. What little does, you wash away quickly between batches using the Pfaudler glassed Spray Rinse Valve. Thus you can expect to put through more product per day.

Lower cost. Glasteel costs less—significantly so—than the alloys you probably would consider in order to protect your product's purity. Just how much you can save will be apparent after you have had a chance to discuss your needs with one of our representatives.

Complete specifications and operating characteristics are covered in Bulletin 932. We'll be happy to send you a copy.

Now, a tantalum heater as large as 124 square feet

Here you see a tantalum bayonet heater believed to be the largest ever produced. It was fabricated by Pfaudler. A special "vacuum purge" welding unit was employed to eliminate the inherent difficulties in welding this metal in the presence of atmospheric gases.

This heater is made up of 52 tantalum tubes, 1½" O.D., and 72 inches long. This adds up to 124 square feet of heat transfer area. Very efficient heat transfer, too, since the 100% corrosion resistance (in those applications where recommended) of tantalum means there's no fouling factor. Also, the high tensile strength and no need for corrosion allowance make possible thin wall construction.

As you might expect, this heater is a custom unit, and it's being assembled into a custom-made Glasteel reactor. In fact, most of the quite extensive line of equipment we make from the refractory metals is to specifications.

What we offer for your consideration is the know-how in fabricating *tantalum*, *titanium*, and *zirconium* into a broad range of items—vessels, heat exchangers, bayonet heaters, columns, burners, accessories, baffles—just about anything you might need.

For particulars write for our Bulletin 978. Or outline in general detail your specific equipment requirements.

Valveless filter ends operating expense and maintenance

Two years ago these Permutit valveless filters were installed to handle water used in process, boiler feed and drinking.

Since then they have been in satisfactory around-the-clock operation. The filter beds and underdrain systems stay clean with no evidence of blowholes or sifting of filter media through the underdrain system.

Completely automatic, these filters require no human attention in normal operation. And they cost up to 45% less than conventional automatic gravity filters because you have no valves, flow controllers, pumps or control systems.

Lots more facts in Bulletin 922. Write for a copy.

For information on the complete line of Pfaudler Permutit equipment, ask for a copy of our FLUIDICS Buyer's Guide.

Address requests to our Pfaudler Division, Dept. PR-90, Rochester 3, New York.

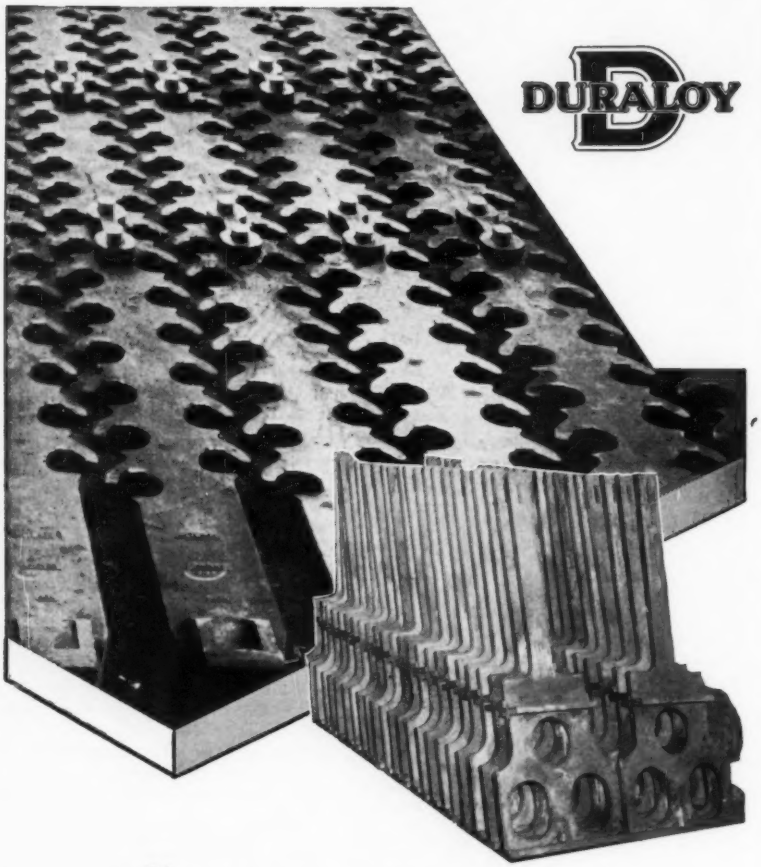
*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS ... the science of fluid processes

For more data on advertised products, use Readers' Service Cards, last page.

CORROSION RESISTANT
HEAT RESISTANT
Tube Supports



You can't buy Better Tube Supports . . . DURALOY Tube Supports are alloyed to meet individual corrosion and heat requirements. They are alloyed by experienced metallurgists and melted and cast by experienced high-alloy foundrymen, both groups with experience going back some thirty years. Castings are carefully tested in our own laboratories which are completely equipped for metallurgical, chemical and physical testing.

Many refineries have been DURALOY customers for years. Many refineries insist upon DURALOY castings. Whether it's straight production or engineering plus production, we are equipped to do the job. For more information, send for Bulletin No. 3150-G.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Men . . .

Nebraska and prior to his latest promotion was on special assignment in the company's headquarters, Bartlesville, Okla.

Alfrey

Nummy

Dr. Turner Alfrey, Jr., has been named a research scientist by The Dow Chemical Company. Dr. Alfrey resigned his position as director of the Polymer Research Laboratory to take the post. He is also being appointed a special consultant to the Plastics Department. **Dr. William R. Nummy** will assume Dr. Alfrey's administrative duties in the Polymer Research Laboratory with the title of assistant director. Dr. Nummy has been assistant director of the Physical Research Laboratory since 1956.

Bert S. Taylor, Food Machinery and Chemical Corp., New York, has been named assistant director, Mobilization Planning, Chemical and Rubber Division, Business and Defense Services Administration, U. S. Department of Commerce. Taylor graduated from the University of Illinois with a B.S. degree in chemistry, and obtained his master's degree at Harvard. He has been with Food Machinery and Chemical Corp. since 1951.

Karl Haefner has joined Whiting Research Laboratories, Standard Oil Co. (Indiana). He will study applications of metallurgy in petroleum refining. Haefner obtained degrees in chemistry and metallurgy in Switzerland and England. He was formerly with Nalco Chemical Co.

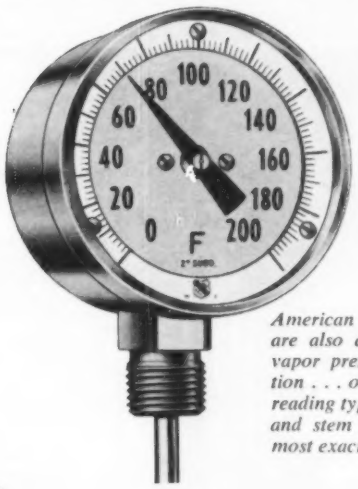
Russell V. Theiss has joined the Engineering Department, Monsanto Chemical Co.'s Inorganic Chemicals Division. He is a graduate of Northwestern University with an M.S. degree in chemical engineering.

Stephen D. Bechtel, president of Bechtel Corp., San Francisco, has been selected as the 1961 recipient of the John Firtz Medal, which is awarded annually

For more data on advertised products, use Readers' Service Cards, last page.

sharp

AMERICAN BI-METAL THERMOMETERS make accurate temperature readings sharp and sure at all check points



American Dial Thermometers are also available in mercury, vapor pressure, and gas actuation . . . on-the-spot and distant reading types . . . in sizes, ranges and stem lengths to meet your most exacting requirements.

sensitive

Any way you look at an American Bi-Metal Thermometer, you see exact working temperatures.

The two-level "Maxivision®" dial eliminates parallax effects. Numerals are on the lower level. Graduations are on the outer raised ring dial which presents a sheared edge to the tip of the pointer and in the same plane. To make readability even more accurate, the glass and graduated dial are closely spaced.

American Bi-Metal Thermometers are made of weather-proof stainless steel. All joints are welded to solid unity, then polished smooth so corrosion won't build up and destroy the thermometer's usefulness. And, you don't have to discard this thermometer even if the glass is ever broken. The bayonet lock bezel makes replacement easy.

Learn about the high sustained accuracy and long service life built into American Bi-Metal Thermometers. Phone your nearby industrial supply distributor for help in selecting the right type for each temperature check point in your plant. Or write for Catalog 100A.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

AMERICAN INDUSTRIAL THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

for notable scientific or industrial achievement in the engineering profession. Bechtel has been with the company which bears his name for 42 years.

Feisal Mansour Mazidi and Mahmould Khalid al-Adasani have been nominated to become directors of Kuwait Oil Co. Both men are natives of Kuwait. Mazidi is an economist, and Adasani is a petroleum engineer who graduated from the University of Southern California.

Donald J. Lindley has joined the Whiting research laboratories, Standard Oil Co., (Indiana). He will study the effects in engines of new compounds developed to improve motor oils. Lindley obtained his bachelor's and master's degrees in enginering at Ohio State University.

Fritts W. Thomas has been appointed process engineer, Engineering Department, Monsanto Chemical Co.'s Inorganic Chemicals Division. Thomas graduated from the University of Tennessee in 1951 with an M.S. degree in inorganic chemistry.

Dr. Robert R. White has been elected a vice president of The Atlantic Refining Co. He was also appointed general manager of the Research and Development Department. Dr. White has been serving as director of the Institute of Science and Technology at the University of Michigan. Previously he was associate dean of the College of Engineering and the Horace H. Rackham School of Graduate Studies at the university. He completed his undergraduate work at Cooper Union Institute, New York, and obtained his doctorate in chemical engineering at the University of Michigan.

White

David C. Liu has been named associate in charge of Dames & Moore's Honolulu office. Liu holds a bachelor's degree in civil engineering from Kung Shang College, Tientsin, China, and a master's degree from Oregon State College. Dames & Moore deals with consulting services in soil mechanics and engineering geology.

George R. Owens has been elected president of ITEC Corp. He joined ITEC in 1958 as a chief engineer. He was previously with such firms as Ralph M. Parsons Co., Pacific Gas & Electric, Utah Construction & Mining Co., and J. H. Pomeroy Co. A member of the American Society of Military Engineers, Owens has worked on construction projects throughout the United States, in Australia, Saudi Arabia and Europe.

Owens

Irvin P. Seegman has been elected vice president, Products Research Co. Seegman, who joined the company in December 1950, will continue in his capacity as technical director in charge of the firm's research, development and manufacturing operations.

John C. Martin has been named senior research engineer, Reservoir Engineering Co., La Habra Laboratory. Martin holds degrees in mechanical and electrical engineering from Clemson College and North Carolina State College. He was formerly with Creole Petroleum Co., Maracaibo, Venezuela.

E. F. Glasgow has been named superintendent of the Oklahoma district, Natural Gasoline Department, Phillips Petroleum Co. Glasgow joined Phillips

9 YEARS AND 973 JOBS LATER!
SMITHCO, whose only business is air cooled heat exchangers, has filled 973 separate orders since 1951. We hope you'll pardon us if our pride shows a little, but we believe our nine year record of continuous growth deserves your attention.
During our brief history we have seen air cooling evolve from an experiment to an exact science. First we cooled water, then gas. As we gained experience and know-how, we successfully met and overcame the problems involved in the cooling and condensing of light hydrocarbons. Today, SMITHCO is able to apply air cooling to any material that will flow through tubes.
One prominent reason for the wide acceptance of our coolers is the Molecular Bond fin tube. SMITHCO is the only builder of industrial air cooled heat exchangers that provides this unique engineering feature which furnishes an uninterrupted metallic thermal path for flow of heat from the inside of the tube to the outermost edge of the fin.
When cooling problems arise, why not put our nine years of progress to work for you? SMITHCO has the facilities and engineering ability to produce a complete range of air cooled heat exchangers from the simple water cooler to the most complicated process coolers and condensers.
SEE OUR CATALOG IN REFINERY CATALOG
OR SEND FOR A COPY

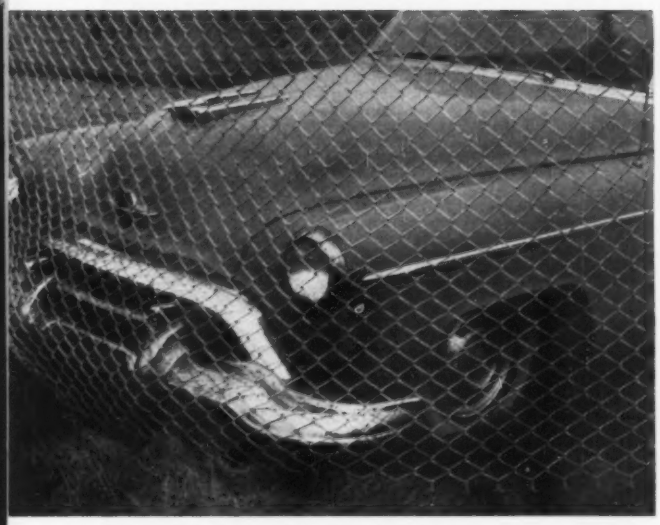
Combination Iso-stripper Recycle Condenser and Debutanizer Condenser in a Western Refinery.

SMITHCO
ENGINEERING INC

P O BOX 3217 PHONE GI 7-5545 TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

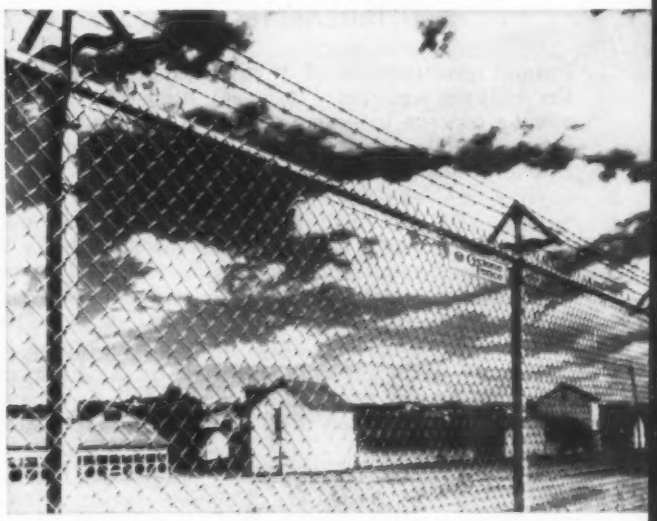
Tests Prove USS Cyclone Steel Fence Quality



Impact Test. A 4000-pound car, traveling at 35 miles per hour, was driven directly into a panel of Cyclone Chain Link Fence Fabric. The car was stopped. The fence did not break or fail—proof that Cyclone Steel Fence has the strength to withstand severe impact.

Fire Test. This raging fire was deliberately set to test the heat resistance of Cyclone Steel Fence . . . and that rugged steel fabric did not melt or fail. Should a grass or trash fire break out too close to a Cyclone Fence, there will be no damage.

Corrosion Test. More than 10 years ago this panel of Cyclone Steel Fence was installed 45 feet from the ocean. Even in this extremely corrosive atmosphere it is still strong and serviceable. Cyclone Fence owes its unusual corrosion resistance to its heavy coating of zinc.



Time Test. The fence shown here is a 25-year-old Cyclone veteran . . . still giving good service. Once Cyclone Fence is properly installed, it requires almost no maintenance. It continues to give good service, year after year.

For additional information on USS Cyclone Fence, write to Cyclone Fence, American Steel & Wire, Dept. O-396, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

USS and Cyclone are registered trademarks

American Steel & Wire
Division of
United States Steel

Cyclone Sales Offices Coast to Coast

Now ...a solution to the size problem in process piping!

ACIPCO CERAM-SPUN STEEL TUBING

...offers a wider range of O.D.'s from 2.25" to 50"; wall thicknesses from .25" to 8"; lengths up to 20'.

Prompt procurement of tubular process piping for the refinery and petro-chemical industries has become a concern to design engineers as specified sizes have steadily progressed to larger diameters and heavier walls.

Now, size can be less of a problem . . . thanks to new ACIPCO CERAM-SPUN tubing. This revolutionary process has resulted in the availability of centrifugally spun process piping in practically every conceivable variation of diameter and thickness . . . and without costly tooling charges. Here is greater freedom in design . . . and increased savings.

Retorts, reformer and furnace tubes, heat exchangers, as well as many other pieces of equipment, have been fabricated from ACIPCO centrifugally spun tubing.

Investigate the advantages of ACIPCO CERAM-SPUN tubing. ACIPCO's complete facilities offer service from centrifugal or static castings to finished parts.

ASA Code for Pressure Piping — Petroleum Refinery Piping (ASA B 31.3-1959) authorizes the use of centrifugally spun stainless pipe made in compliance with ASTM Specification A426-58T. This specification is entitled, "Centrifugally Cast Ferritic Alloy Steel Pipe for High Temperature Service." Write for a free copy.

SIZE RANGES: Tubes are produced in lengths from 4' to 20'; longer lengths are made by welding. O.D.'s from 2.25" to 50" — wall thicknesses from .25" to 8".

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels, plain carbon steel and special non-standard analyses.

FINISHES: As cast, rough machined, or finished machined, including honing and grinding. Complete welding and machine shop facilities are available.

ACIPCO
SPECIAL PRODUCTS
DIVISION OF ACIPCO AMERICAN CAST IRON PIPE CO.
BIRMINGHAM · ALABAMA

Men . . .

in 1933 after graduating from the University of Oklahoma. He has served as assistant superintendent and engineer in the Oklahoma district since January 1959.

Dr. Alexander Lewis, Jr., has been elected a vice president of Gulf Oil Corp. Formerly manager, Petrochemical Department, for Gulf, Dr. Lewis will continue to direct the company's petrochemical interests, which include the manufacturing of ethylene, propylene, benzene, toluene, isooctyl alcohol, and detergent raw materials. He began working for Gulf in 1935 at its Philadelphia refinery while still a student at Ursinus College. After receiving a B.S. degree in chemistry in 1938, he joined Gulf on a full-time basis as an organic chemist, Refinery Technology Laboratory, Philadelphia. He received his M.S. degree from the University of Pennsylvania in 1940.

Lewis

— Deaths —

Charles H. Lane, 74, a director of Gulf Publishing Co. since 1918 and an independent oil operator since 1924, died August 13 at his home in Houston. He was an organizer of the E. F. Simms and Co. and was office and field manager for the company. He served as drilling and mechanical advisor for Gulf Publishing for many years. Lane was connected with Texaco, Inc., when the company was formed.

Michael Halpern, 67, former senior vice president and director, Texaco, Inc., died August 16. He was vice president in charge of the company's Refining Department from 1940 to 1954, and was senior president in charge of its worldwide refining interests and activities for three years until his retirement in 1957. He was a director in the firm from 1946 to 1957.

R. Paul Huggins, former vice president of Gulf Oil Co., died August 9 at his home in Houston, Texas. Huggins had been with Gulf Oil for 38 years when he retired in January 1959. He was vice president of Permian Oil Co. since he retired. Huggins was in charge of crude oil and products supply with Gulf.

DuBois Eastman, 54, director of the Montebello Research Laboratory, Texaco, Inc., died August 12 after a long illness. He joined Texaco in 1928 as a chemical engineer upon graduation from the University of California.

NEW SCAM®

MAGNA-PLAC

NAMEPLATE

Your systems' sentry, Scam De-Line annunciators, now offers a new MAGNA-PLAC nameplate which provides a full 10½" of engraving area—70% more than conventional nameplates.

MAGNA-PLAC gives engineers increased area to more accurately describe condition variations or to employ larger characters for greater visibility. MAGNA-PLAC is interchangeable with standard Scam nameplates and optionally available on De-Line units *without extra charge.*

Other De-Line features include side by side or stack mounting for practical, *economical* system expansion; a single plug-in relay for both normally open *or* normally closed contacts; and sequence options *after* installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

Complete Monitoring Systems for Industry

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WRITE FOR MORE INFORMATION on De-Line MAGNA-PLAC. Just sign and attach coupon to company letterhead.

NAME _____

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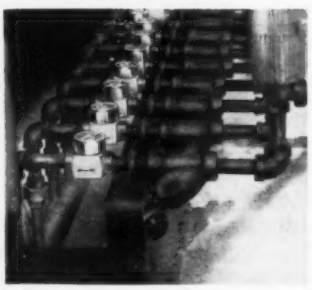
SARCO TOPICS

HOW TO SOLVE COMMON TRACER LINE PROBLEMS

How to cure water hammer with a steam trap that will operate in vertical position

Water hammer is an inherent problem in long tracer lines. So is freezing. Both problems can be overcome, and here's an example of how it has been done. At the Socony Mobil Oil Company's Paulsboro, N. J., refinery, they found that the Sarco Thermo-Dynamic Steam Trap, type TD-50, not only withstands water hammer, but installing the trap in a vertical position —which permits free drainage—presents no problems at all, thanks to its unique thermodynamic principle. In fact, 90% of the 250 TD-50's at this plant are vertically mounted. They never block heat transfer, and they remove condensate and air as fast as they collect.

How to handle varied steam pressures — without adjustment



Can a trap — without adjustment — handle steam pressures that vary from 15 to 160 psi? Can the *same* trap vent air and drain condensate as rapidly as it is formed, be easy to install and require practically no maintenance at all? That was the problem set up by the engineering staff of Armour Chemical Division's McCook plant. They solved it by testing many traps. Their conclusion: Sarco TD-50 steam traps meet or beat their specifications, because:

they discharged condensate as fast as it formed, without wasting steam;

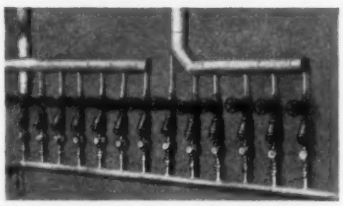
their compact inline construction made installation easy, even in tight quarters;

maintenance was practically negligible;

no adjustment was necessary for varying steam pressures. (In fact, the TD-50 is self-adjusting through its full operating range of 10-600 psi.)

No other steam trap can so adequately solve all these problems at one time.

How to be certain process fluid stays above 280° F. when outside temperature drops to −10° F.



The problem of maintaining design temperatures on tracer lines need not be difficult, no matter how extreme the conditions seem to be. For example, the tracer lines in a phthalic anhydride process at Witco Chemical Company's new Chicago plant had to be maintained above 280° F. Below this temperature, the chemical sets and the whole system would have to be taken apart and re-assembled. That's not all; ambient temperatures sometimes could drop to −10° F.

With reliability as a prime consideration, Scientific Design Company, Inc., who designed and constructed this brand new plant, selected the TD-50.

Because the TD-50 can be mounted vertically, freezing was no problem either. Added benefits that matter on tracer lines: the TD-50 is compact, light in weight, easy to install.

What is the most reliable tracer line trapping method to prevent unscheduled shutdown?

Particularly in refineries, steam traps have to function under exactly the kind of conditions that you'd expect to cause failure—they must function equally satisfactorily on low pressure or exhaust steam and on up through high-pressure, high temperature ranges. Not only that, but outside temperature may vary from subzero to subtropical. If maintaining design temperatures in your tracer lines appears to be hampered by these problems, consider how Phillips Petroleum Company, Kansas City, solved them. They found a trap which drains their tracer lines automatically over a full range of pressure, temperatures and loads. It's the Sarco TD-50 Steam Trap.

With only one moving part—a stainless steel disc, the TD-50 has little that can go wrong. In fact, it's so free of trouble that Phillips Petroleum Company consider their TD-50's as reliable and efficient as the piping. They now rely on 1800 of them throughout the plant. 1408

FOR FULL INFORMATION ON TRACER LINE TRAPPING or on any steam trapping problem—see your Sarco Sales Representative or write to

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

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SARCO

Here are 7 Sound Reasons Why the Thermo-Dynamic® Does a Better Job of Trapping

1. *Simplicity*—has only one moving part. 2. *Maintenance*—practically zero. 3. *Wide pressure range*—one trap for all pressures from 10 to 600 psi. 4. *Uniform performance*—operates equally well on heavy, light, or no condensate load. 5. *Operates against back pressures*—up to 50% of inlet pressure. 6. *Rugged*—unaffected by superheat, water hammer, vibration, or corrosive condensate. 7. *Minimizes inventory* of spare parts.

Maintenance Time: 40 Seconds. If it now takes your maintenance crew more than a couple of minutes to service an ordinary trap, you're throwing away valuable time. This Sarco Thermo-Dynamic can be cleaned, blown out if necessary, and reassembled on the line in as little as 40 seconds.

For Prompt Information on the TD-50 . . . or for fast help on the efficient solution of any steam trapping problems, get in touch with a SARCO District Office, Sales Representative, or Distributor. (There's one near you.)

Only SARCO makes all 5 types:

Thermo-Dynamic* • Thermostatic • Liquid Expansion • Float Thermostatic • Inverted Bucket

*U.S. Pat. No. 2,817,353 TM Reg. U.S. Pat. Off. 1400

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

Suppliers Notes...

Goulds Pumps, Inc., have established a separate corporation to handle all export sales known as Goulds Pumps International, Inc. Offices of the new company are located at 260 Madison Ave., New York. Ronald Gilbert, left, general sales manager, Goulds Pumps International, Inc., discusses market coverage to be provided by the company with Eric E. Backlund, vice president, Goulds Pumps, Inc.

SPERRY RAND CORP.'s Remington Rand Univac Division has named **John C. Croyle** director of customer services. Croyle has spent the past 25 years with the International Business Machines Corp. He joined IBM in 1935 in the Customer Engineering Department, Endicott, N. Y. In 1958, he was appointed regional manager of IBM's customer engineering, Western Division Data Processing, a position he has held up to the present. He received his B.S. degree in electrical engineering in 1934 from Bucknell University.

Croyle

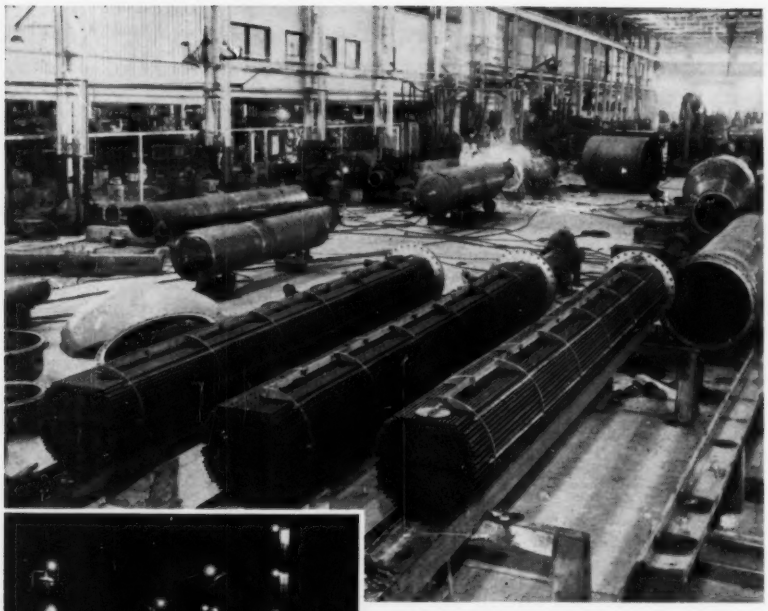
DELTA TANK MANUFACTURING CO. INC.'s Dryex Division has named **Spencer H. Landes** and **James I. Montgomery** managers. Landes, who joined Delta Tank earlier this year, will manage Delta's Dryex Division in Houston, and Montgomery will serve as assistant manager. Landes has been a process engineer and research chemist with petroleum firms. Montgomery worked with an engineering consulting firm, and in the writing, coordination and design departments of the oil business.

YUBA CONSOLIDATED INDUSTRIES, INC. has purchased the K. W. Anderson Co., Tulsa, manufacturers of high temperature furnaces for processing industries. The Anderson Co. is being consolidated with the Petro-Chem Development Division of Yuba. Sales activities of the combined organizations will headquarter out of Tulsa. **Kenneth W. Anderson,** formerly president of the K. W. Anderson Co., will be vice president and general manager of the Petro-Chem Development Division of Yuba.

CLIMAX MOLYBDENUM CO., a division of American Metal Climax, Inc., has named **Kenneth B. Wood, Jr.,** manager, Chemical Division. He replaces **Elwin E. Smith,** now general sales manager for Climax Molybdenum. Wood had been manager of lubricant development. He joined the firm in 1956 after serving as regional manager of lubricant sales for Cities Service Oil Co. He graduated from the University of Virginia, and is a member of the American Society of Lubrication Engineers.

Wood

For more data on advertised products, use Readers' Service Cards, last page.



FLINT can fabricate any type of petroleum and chemical PROCESSING EQUIPMENT

HEAT EXCHANGERS

BUBBLE TOWERS

PRESSURE VESSELS

FRACTIONATING COLUMNS

More than forty years of manufacturing experience, the largest and the most modern plate shop facilities in the Southwest enable Flint to design and fabricate, to code, and meet delivery requirements competitively.

Fabricated Structural Steel
Fabricated Galvanized Steel
Steel Service Center

Write for booklet describing Flint's new steel fabricating facilities.

FLINT STEEL

P. O. BOX 1289 • LU 4-3621
TULSA 1, OKLAHOMA

STEEL PLATE FABRICATORS ASSOCIATION

SPECIALISTS IN STEEL FOR INDUSTRY

Suppliers . . .

ALLOY TUBE DIVISION, The Carpenter Steel Co., has appointed **John T. Lurcott** territorial sales manager, New York area. Lurcott has been a product engineer at the division's Union, N. J., plant. His territory includes New York City, Long Island, and all of New England. He graduated from the University of Rochester in 1956 with a B.S. degree in chemical engineering and worked as a product service engineer with Ethyl Corp. before joining Carpenter Steel in 1959.

Lurcott

GOODYEAR PUMPS, INC., has announced the signing of a manufacturing agreement with Warren Pumps, Inc., initiating the production of the Goodyear Archimedean rubber-to-metal screw pump now supplied to the chemical, industrial, marine and fire fighting markets. The Goodyear Pump is presently imported from England but increased demand by the process industries for this pumping principle has necessitated American manufacture. Nationwide sales and distribution will be directed by Goodyear Pumps, Inc., through their present representatives and distributors.

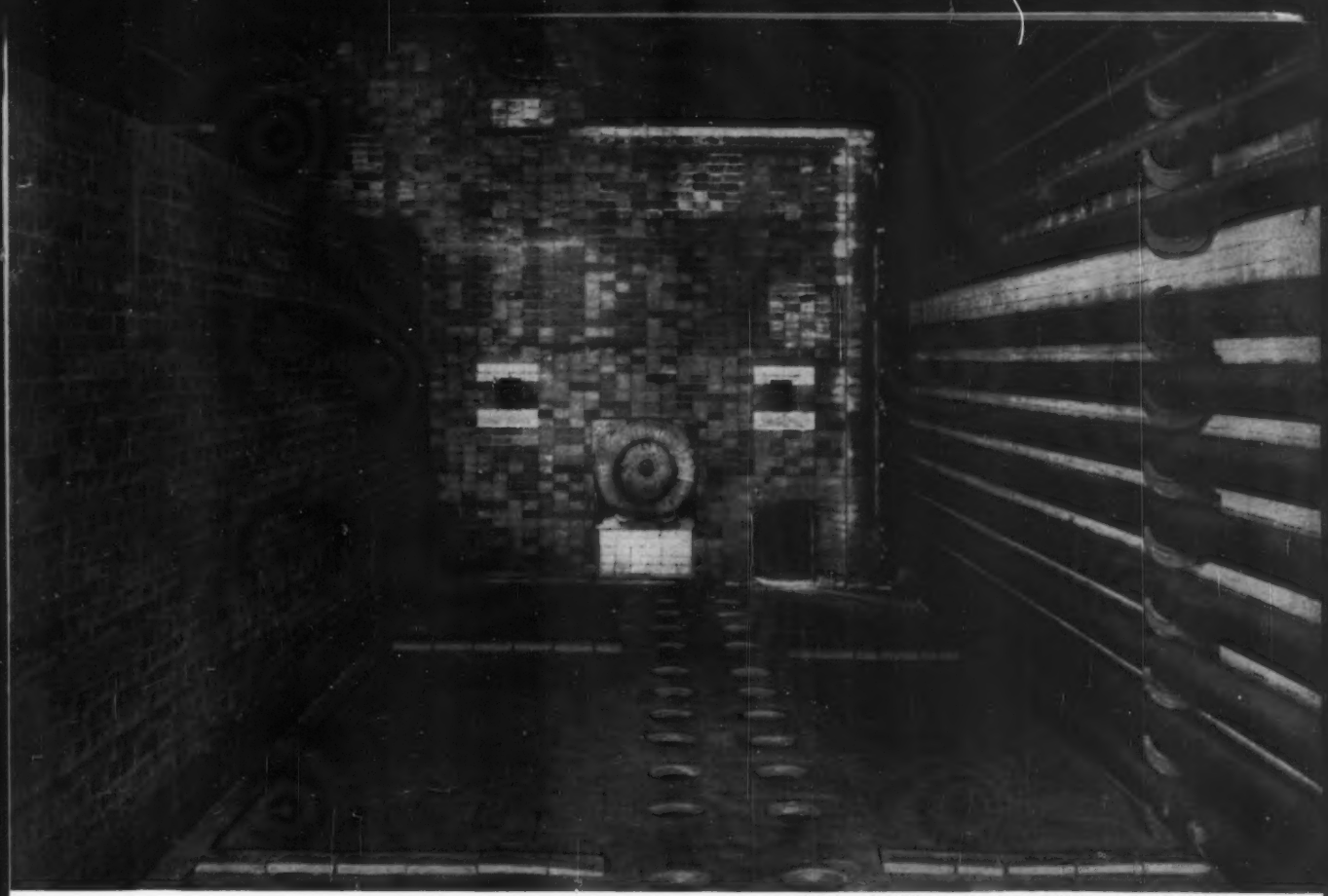
PENNSALT CHEMICALS CORP. has named **Douglas F. Woolley, Jr.,** manager of the Eastern Seaboard Region for the Corrosion Engineering Products Department. Woolley, who has been a sales representative for Pennsalt's line of corrosion resistant mortars, coatings, and plastics in the middle Atlantic states for more than three years, will have his headquarters in Philadelphia.

NALCO CHEMICAL CO.'s Industrial Division has named **John B. Cruell** manager of its Southern California district. Cruell, formerly area manager of Nalco's New York City office, joined the company in 1955 as a field representative in the Texas district. He was promoted to area manager, New York City, in January 1959.

ENJAY CHEMICAL CO. has named **C. J. G. Leesemann** manager of chemical marketing, Western Sales Division. **D. G. Bunnell** has been appointed manager of the Houston sales district. The Western Division, with headquarters in Houston, markets chemical products in Texas, Oklahoma, Arizona, New Mexico, Idaho, Utah, Nevada, California, Oregon and Washington.

LUCEY PRODUCTS CORP. has named **C. Ray Grosvenor** manager, Refinery, Chemical Plant and Pipe Line Department. Grosvenor, who is a professional engineer, has worked with Bechtel Corp., Foster-Wheeler Corp., Arthur G. McKee Co., Girdler Corp., The Refinery Engi-

For more data on advertised products, use Readers' Service Cards, last page.



Interior of Oil Heater Lined with B&W Insulating Firebrick.

B&W Refractories stay on stream

Long refractory life, low furnace maintenance, and dependable service result from the use of B&W Refractories. B&W offers a wide line of *specialized* refractories *engineered* to give you maximum furnace availability and economy.

Naturally, the refractory selected depends on the specific service. B&W Insulating Firebrick, for example, serve a dual role. First, these durable, lightweight IFB are most efficient insulators, and second, they withstand direct exposure to furnace heat. This means . . .

REDUCED CONSTRUCTION COSTS—The lightweight and high insulating value of B&W IFB combine to lower material costs and simplify furnace design. Because they withstand furnace heat, they eliminate the need for dense refractory constructions backed up with insulating materials. This, together with lightweight, means thinner, lighter wall constructions, often providing savings in structural steel and foundation costs.

REDUCED OPERATING COSTS—The high insulating value of B&W IFB means savings in everyday operation. Per inch of thickness, B&W IFB provide more insulation than any other refractory lining. Less heat is lost, casing temperatures are lower, working conditions are improved and efficiency is increased.

Furthermore, since B&W IFB are light in weight, they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

This low heat storage also permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Consult your B&W Refractories Representative for assistance with your refractories problem or write to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

R-628

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

LOW COST
light weight
FORGED
carbon steel

NOM. I. P. S.
1/2" thru 8"

back-up flanges
CAMCO

FOR USE WITH SCHEDULE 5 and SCHEDULE 10 STAINLESS STEEL STUB ENDS and PIPE

Can be used with slip-on or lap joint stub ends where pressure and temperature problems are not encountered and Stainless is utilized to avoid contamination or corrosion.

Flange surfaces protected with a baked enamel finish.

THE Quality LINE IN FITTINGS
CAMCO
FITTINGS, INC.
301 STATE STREET
NORTH HAVEN, CONNECTICUT

For prices and dimensional data send for Schedule FCS-460

Suppliers . . .

neering Co. and the Sapulpa Tank Co. He will make his headquarters in Tulsa.

HEYDEN NEWPORT CHEMICAL CORP.'s Newport Industries Co. has appointed **E. C. Slaght, Jr.,** technical director and assistant to the president. Slaght, who has been manager of Heyden Newport's Market Development Department, New York, will organize and coordinate the company's expansion and new products programs.

B. F. GOODRICH TIRE CO. has named **John Waroblak** manager of dealer expansion. Waroblak joined B. F. Goodrich in 1949. He graduated from Bucknell University, Lewisburg, Pa.

CELANESE CORP. OF AMERICA has appointed **John W. Brooks** and **Richard W. KixMiller** executive vice presidents. Brooks and KixMiller both had been corporate vice presidents, with Brooks in charge of the Fibers Division and KixMiller heading the chemical and plastics divisions.

UNIVERSAL OIL PRODUCTS CO. has named **W. F. Bliss, Jr.,** product sales representative for the Gulf Coast area, operating out of Houston. An eight-year veteran of the petroleum, petrochemical and chemical industries, Bliss was with Geigy Industrial Chemicals Division before joining UOP. He has a B.S. degree in chemistry, and did graduate work at the University of Chicago.

Bliss

BURGESS-MANNING CO.'s Industrial Silencer Division has named **George F. Kelley** sales engineer in the New York City district office. Prior to joining Burgess-Manning, Kelly was a procurement engineer for Welding Shipyard Division, National Bulk Carriers. He graduated from the U.S. Maritime Academy.

THE COOPER-BESSEMER CORP. has named **Donald A. Harnsberger** technical coordinator, International Division. Harnsberger holds a B.S. degree in mechanical engineering from Massachusetts Institute of Technology and an M.S. degree in nuclear engineering from the University of Michigan.

ALLIS-CHALMERS MANUFACTURING CO.'s Industrial Equipment Division has named **G. A. Saar** general manager, Mechanical Department, and **W. M. Terry, Jr.,** general manager, Electrical Department. Saar, who had been assistant general manager of the Industrial Equipment Division, is now responsible for the processing machinery, compressor and West

CUT FUEL BILLS 20% WITH A LJUNGSTROM® AIR PREHEATER

The world's largest fluid catalytic cracker at Esso's Bayway Refinery is equipped with a new Ljungstrom Air Preheater. This picture shows the half-ton cold-end elements being installed in the Ljungstrom rotor.

Your biggest refinery operating expense is the money you burn: fuel costs. You can chop fuel bills ⅓ with a Ljungstrom Air Preheater, and here's how:

Your fuel bill drops about 1% for every 45-50°F you raise the temperature of combustion air. Ljungstroms now in service raise the air temperature 1000°F or more – and the rest is simple arithmetic. With a Ljungstrom, four barrels of fuel do the work of five. On fuel savings alone, one eastern refinery came up with net savings of $67,800 in the first year they used a Ljungstrom.

SAME FUEL, MORE HEAT. Ljungstrom economy is flexible economy. If total throughput is more important to you than fuel savings, a Ljungstrom can help boost the capacity of a pipe still at least 10% a day, without any increase in fuel consumption.

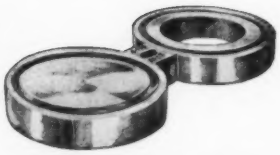
THESE ARE FACTS backed up by 25 years of Ljungstrom performance in refineries all over the world. But they're not the only facts. To find out about Ljungstrom's low-cost maintenance, easy inspection, in-service cleanability, space-saving compactness, call or write The Air Preheater Corporation for a free copy of a brochure called "The Ljungstrom Air Preheater for Process Equipment."

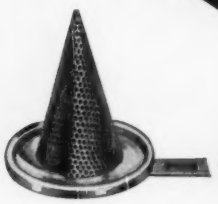
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

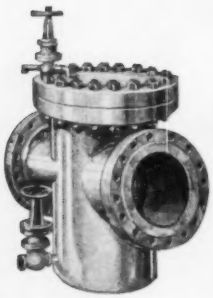
LITTLE TAG . . . BIG MEANING!

Not a mere name plate, this little metal tag on a piece of equipment is unreserved assurance of quality workmanship and dependability of service . . . *priceless characteristics not solely measured in dollars and cents.*





MANUFACTURED BY THE MACK IRON WORKS COMPANY SANDUSKY OHIO U.S.A.



MAC-IRON CATALOG A-9

Although you'll find our full line Catalog A-9 in the current REFINERY CATALOG wouldn't you like more copies for distribution among your important engineering personnel?

Your request will bring all the copies you need.
WRITE TODAY . . .

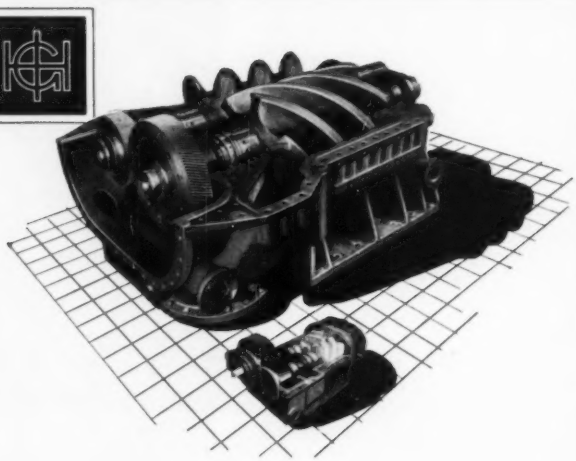
THE MACK IRON WORKS COMPANY
121 Warren Street
SANDUSKY, OHIO
Phone MAin 6-3712

SPECIALISTS TO PETRO-CHEM-REFINING AND CHEM-PROCESS INDUSTRIES SINCE 1901

Stock and custom made items for many engineered applications which involve pumping of fluid materials and operational liquids.

BLINDS • SPACER RINGS • STRAINERS • PIVOT FLANGES

GHH SCREW COMPRESSOR



- **Oil-Free Operation**
- **No Metal-to-Metal Contact of rotating elements**
- **Over 400 Units in Operation handling air, hydrocarbons, and many other gases**
- **Suction Volumes 350 to 15,000 cfm**
- **Compression Ratios up to 1:4 for single stage and 1:10 for two-stage units**

GUTEHOFFNUNGSHÜTTE

STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

REPRESENTATIVES: THE FORAM CORPORATION
50 BROAD STREET, NEW YORK 4, N.Y. Telephone: WHitehall 3-8241

Suppliers . . .

Allis pump departments. Terry was director of engineering coordination for Allis-Chalmers industries since 1957.

Dean

Smith

JONES & LAUGHLIN SUPPLY DIVISION has promoted **R. C. Dean** to store manager, Pampa. He joined Jones & Laughlin as a storeman at Estevan, Sask., in 1955. **J. C. Smith,** formerly store manager at Ballinger, Texas, has been assigned store manager, Anson, Texas. Smith began his career with the company in 1946 at Muenster, Texas. **C. H. Sala, Jr.,** store manager at Anson, Texas, has been transferred as store manager, McPherson, Kan. He came to the firm in 1945 as a storeman in Perry, Okla.

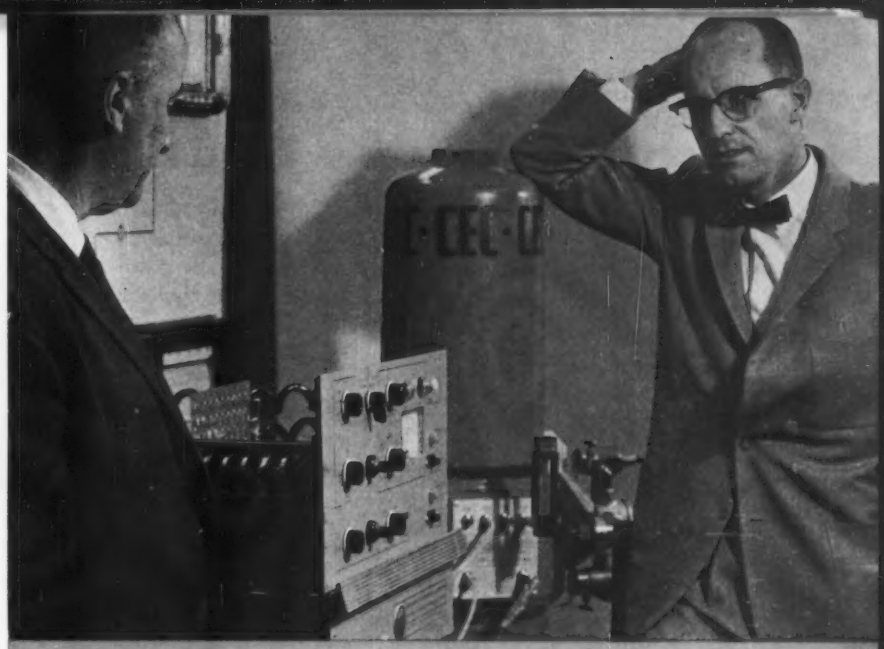
Sala

THE GEOTECHNICAL CORP. has elected **Dr. William B. Heroy, Jr.,** executive vice president. Dr. Heroy joined Geotech in 1945 and was subsequently appointed vice president and member of the board of directors. He will direct and coordinate the operations of the firm, which develops and manufactures instruments and systems for data telemetry, timing and recording and data reduction.

THE BENDIX CORP. has appointed **Robert A. Sweet,** former Eastern Regional manager, sales manager, Computer Division. Sweet, headquartered in Washington, D. C., since 1956, will move to the division's home office in Los Angeles. **Cary Armstrong,** senior sales engineer in the Eastern Region since 1957, has been named new Washington district manager.

BORG-WARNER SERVICE PARTS CO. has elected **A. C. Darling** and **Robert L. Stacey** chairman and president, respectively. Darling has been with the firm for more than 30 years, having been one of its founders in 1929. Stacey joined the company in 1949.

THOR POWER TOOL CO. has named **Gale C. Wicks** assistant to the president in



LOOK INTO CEC's NEW PROCESS CHROMATOGRAPH

. . . for at least four advantages you won't find in other instruments

Here are just four of the reasons why CEC's 26-212 High-Speed Process Chromatograph is the most advanced instrument of its kind. You'll find the 26-212 unique because it offers:

EXTREME FLEXIBILITY. The analyzer accommodates all types and sizes of columns, multiple columns and a variety of detectors. Programming changes for new applications also can be made easily in the field.

HIGH SPEED. The 26-212 is the only multiple-stream, high-speed chromatograph on the market. It's 10 to 40 times faster than conventional units...makes many analyses in just 20 to 30 seconds.

DUAL-ZONE TEMPERATURE CONTROL. Sample metering at temperatures up to 220°C (428°F), and column operation at lower temperatures permits precision analysis of high-boiling, high-endpoint streams.

AUTOMATIC PROCESS CONTROL. Precision, high-speed operation makes possible closed loop pneumatic, electronic, and computer control of rapidly changing petroleum, petrochemical, chemical, and pharmaceutical processes.

The 26-212 is easily serviced in the field. All parts are readily accessible and require no routine maintenance. For more information on this unique new process chromatograph, call your nearby CEC sales and service office or write for Bulletin CEC 1860-X5.

Analytical & Control Division CEC

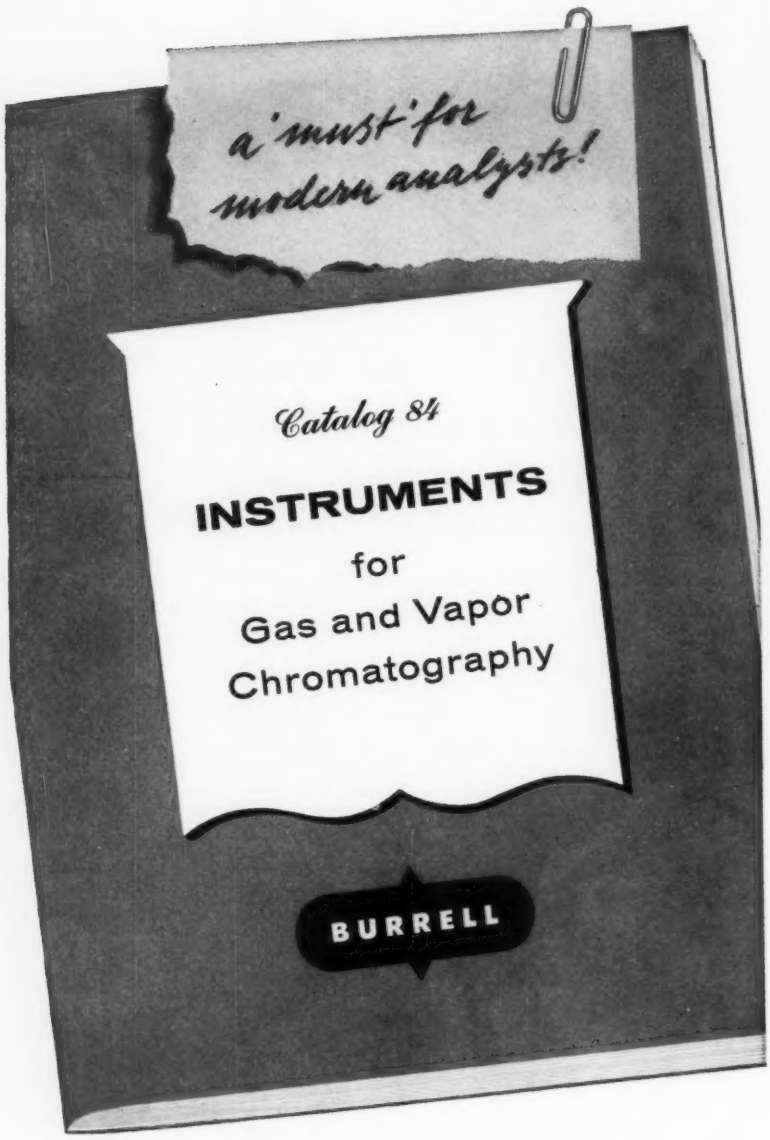
CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell · *FINER PRODUCTS THROUGH IMAGINATION*

"For Scientists Everywhere"

Important new booklet

Now, for the first time in the dynamic history of modern chromatographic analysis, you can have a complete listing of instruments and accessories in one handy volume.



Only Burrell builds a complete series of laboratory instruments for chromatographic analysis, including four models of the versatile Burrell Kromo-Tog for research or process control.

Request Catalog 84

BURRELL *Scientific Instruments and Laboratory Supplies*

BURRELL CORPORATION, 2223 FIFTH AVENUE, PITTSBURGH 19, PA.

Suppliers . . .

charge of liaison with the Drying Systems Division. He joined the company in 1945 as purchasing expediter.

HARDINGE MANUFACTURING CO. has named **Robert L. Johnson** foundry manager. Johnson began his foundry career with Bucyrus Erie Co. He joined Hardinge April 1, 1960.

THOMPSON-ROMA-WOOLDRIDGE, INC., will manufacture and sell its RW-300 Digital Control Computer in Europe through a newly-formed corporation headquartered in Paris. The new firm, Compagnie Europeenne d'Automatisme Electronique, is part of TRW's International Division.

ARMSTRONG CORK CO.'s Packaging Materials Division has appointed **Robert H. Knies** advance industrial designer to work on advance design of new consumer packaging. He joined Armstrong Cork in 1956 after two years of military service. He graduated from Philadelphia Museum College of Art with a degree in industrial design.

DELTA TANK MANUFACTURING CO., INC., has added a branch manager and two employes to the Odessa, Texas, sales departments. **Gary L. Clark** joined the Odessa office as manager earlier this year after serving in tank erection, warehouse and sales departments with other companies. He is a member of the National Gasoline Association of America and the American Petroleum Institute. **Lonnie P. Graham** was appointed sales representative in the Oil and Gas Equipment Sales Department and **Don Burch** joined the Sales and Service Division in February.

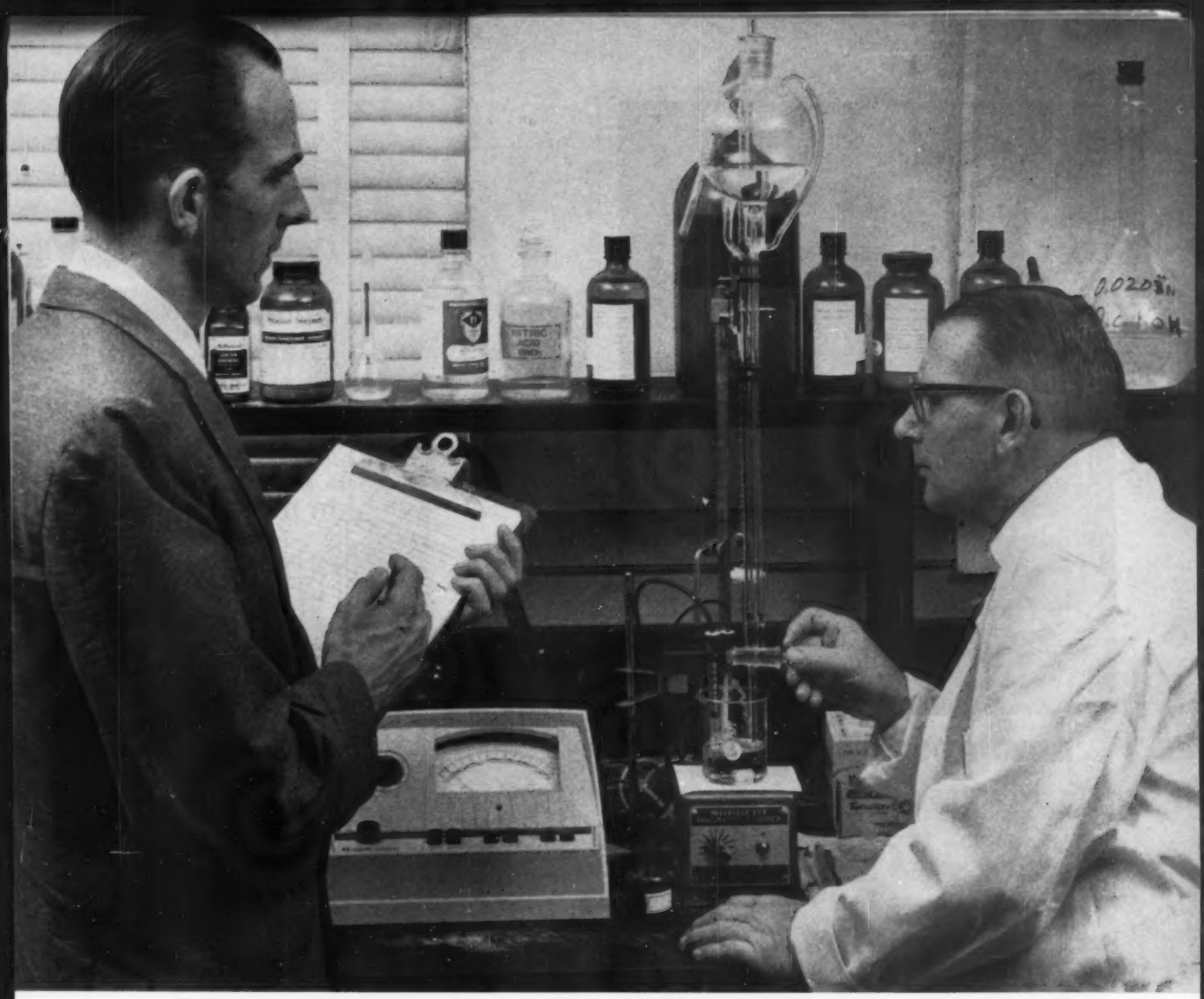
Clark

MULTI-AMP ELECTRONIC CORP. has appointed **Ralph J. Dikeman, Jr.,** marketing manager. Before joining MULTI-AMP, Dikeman was a sales engineer with I-T-E Circuit Breaker Co. He graduated from New York University in 1951.

ALLIED CHEMICAL CORP. has appointed **Ronald Lovatt** sales manager of the calcium chloride section, New York. Lovatt succeeds **H. R. Smith,** who has been named assistant to the manager, Syracuse, N. Y., sales branch. Lovatt joined Allied Chemical in 1937, and Smith joined the company in 1936.

BROOKFIELD ENGINEERING LABORATORIES has appointed **Louis A. DiCorpo** technical sales manager. A graduate of North-

For more data on advertised products, use Readers' Service Cards, last page.



Jefferson Gas Processing Specialist takes your problem to the laboratory

Specific analyses of amine solutions are often needed to pinpoint gas sweetening difficulties. After studying your problem, Jefferson's Gas Processing Specialist will know which analyses to recommend. Frequently, he will request samples to be sent to Jefferson's Austin Laboratories, where analytical equipment and specialized experience, not ordinarily found in plant laboratories, are available.

Let's say your sample is a lean diethanolamine solution and he needs to know such factors as: DEA from alkalinity before and after ion exchange; DEA calculated from Kjeldahl test for total nitrogen; analysis of other nitrogenous materials such as ammonia, thiocyanate, etc.; determination of heat stable salts present; viscosity; alkali metals; iron and iron capacity. Jefferson's Gas Processing Specialist requests and coordinates these tests. His detailed interpretations of the results are correlated with information on your specific operating conditions. Successful remedies to your problem most likely follow.

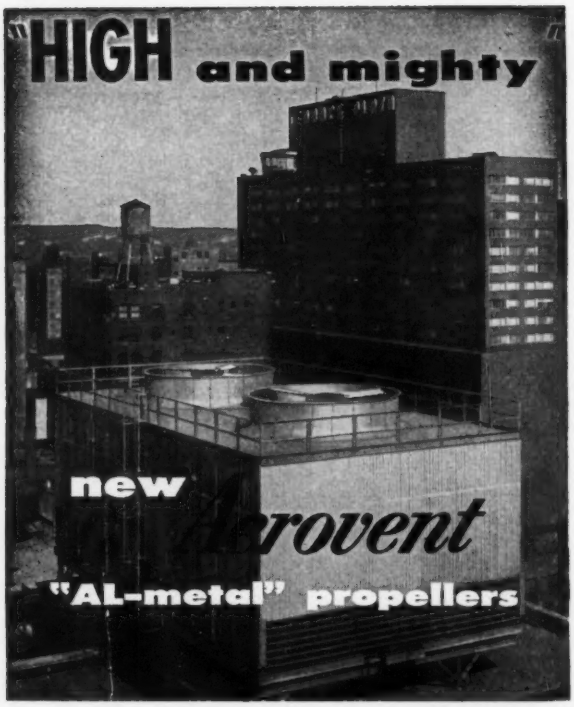
Prompt, dependable technical services plus ethanolamines and glycols in any quantity . . . they're yours from Jefferson Chemical Company, Inc., 1121 Walker Avenue, P. O. Box 303, Houston 1, Texas.

Ethylene and Propylene Oxides, Glycols, Dichlorides, Carbonates
SURFONIC® Surface-Active Agents • Ethanolamines • Morpholine
N-Alkyl Morpholines • Polyethylene and Polypropylene Glycols
Piperazine • Piperazine Salts • Nonyl Phenol • Caustic Soda

HOUSTON • NEW YORK • CHICAGO • CLEVELAND • CHARLOTTE • LOS ANGELES

JEFFERSON CHEMICALS

004



move mountains - of AIR!
in towers and exchangers

- Sizes 14′ to 18′
- 4 or 6 blades

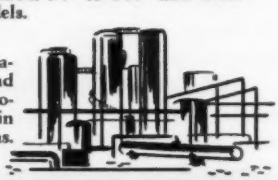
Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

Write for free Bulletin 510

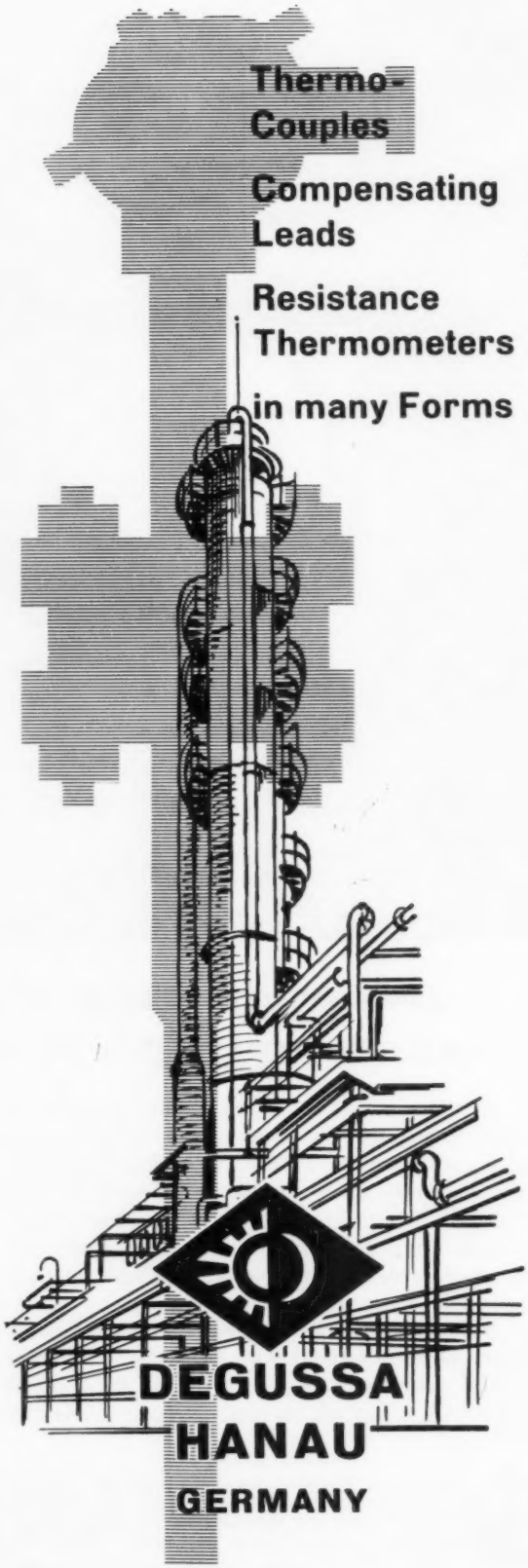
DESIGNED FOR DEPENDABLE OPERATION!

Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54″ to 144″ now available in Adjustable Pitch Models.

REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



Aerovent FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg.
TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO



Suppliers . . .

eastern University, DiCorpo has been with Brookfield since 1953 in both engineering and sales capacities.

GROVE VALVE AND REGULATOR CO. has named **Al Romano** sales engineer in Southern Louisiana. Romano joined Grove after working in the petroleum and gas equipment field. He has been with Shaffer Tool Works, Houma, La., as a sales representative and office manager and is the former co-owner of LIR Construction Co., Inc., Lafayette, La. Romano will make his headquarters in Houma, La.

Romano

U.S. INDUSTRIES, INC. has elected **Robert S. Wright** vice president, international trade. In addition to his new position, Wright will head the operation of the International Division, of which he has been president for the past two years.

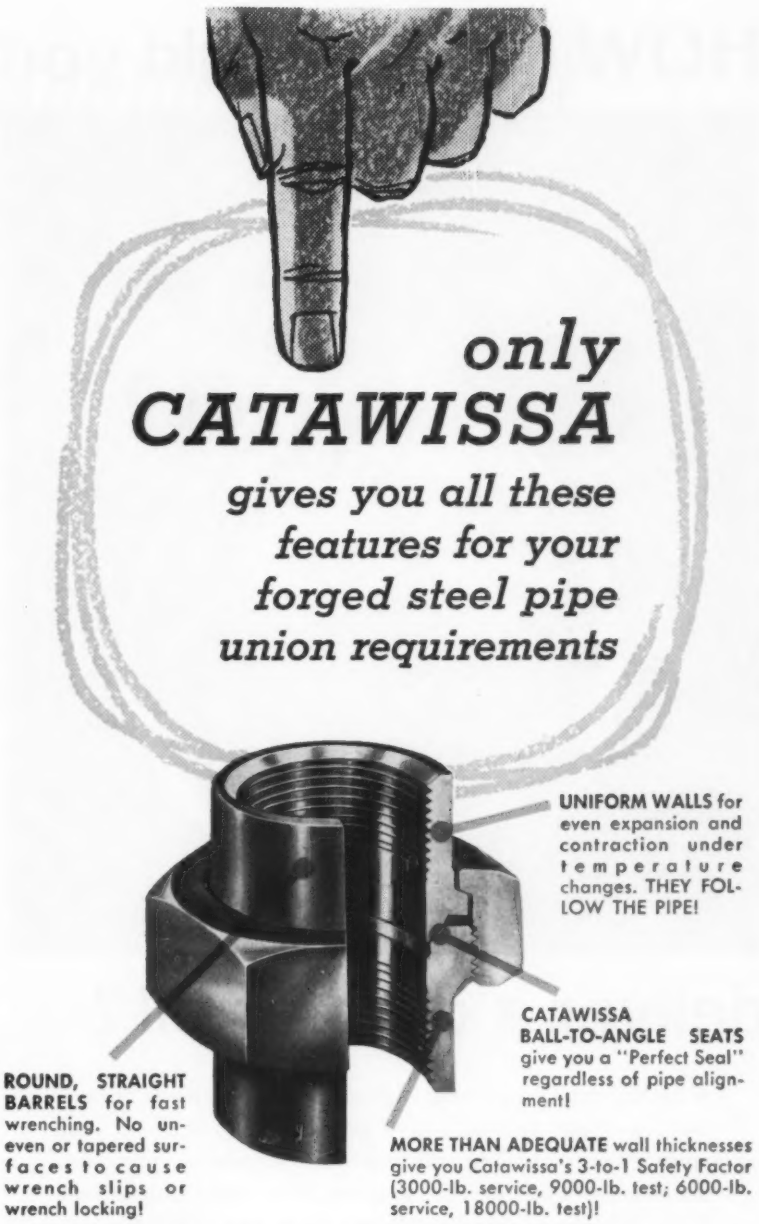
MALONEY-CRAWFORD TANK AND MANUFACTURING CO. has named H & S Service Co., Greggton, Texas, sales and service dealer for the East Texas area. Officials of H & S Service Co. are co-owners **L. C. "Shorty" Hoffman** and **Raymond Sigmon;** and **Allan Hanson,** sales and service manager.

RELIANCE INSTRUMENT MANUFACTURING CORP., Glen Cove, N. Y., has been purchased by Electro-Mech Corp., Norwood, N. J., a wholly-owned subsidiary of American Chain & Cable Co., Inc. The Glen Cove firm will be known as the Reliance Instrument Division of Electro-Mech Corp. **B. C. Webster,** former president of Reliance, will be general sales manager of the division.

DAYSTROM, INC.'s Weston Instruments Division has named **Joseph F. Degen** vice president and general manager. Degen was vice president of operations for Weston Instruments. He joined the company in 1957 as vice president of manufacturing. During 1946 to 1957, he was general superintendent of the Poughkeepsie, N. Y., plant of International Business Machines Corp.

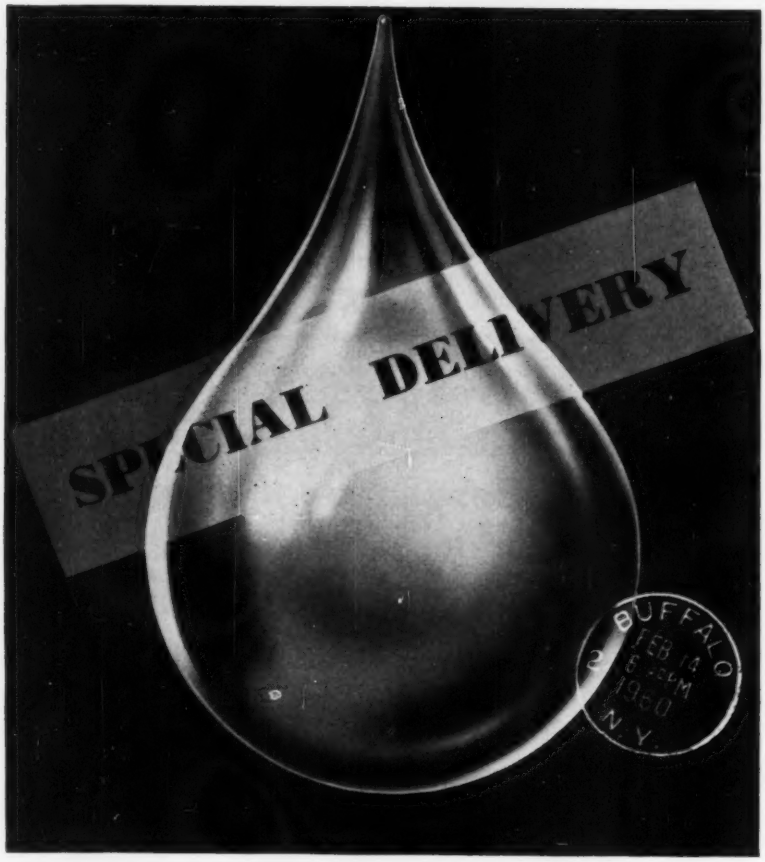
THE BENDIX CORP. has acquired a controlling interest in Disenadores y Constructores, S. A. (Dicosa), one of Mexico's leading tool and die firms. The new company will be known as Bendix de Mexico, S. A. **Alfonso Galan** and **Ricardo Beltran** will serve as president and executive vice president respectively.

CONSOLIDATED ELECTRODYNAMICS CORP. has appointed **Robert L. Baker** chief of the editorial bureau. Baker has been a


only
CATAWISSA
gives you all these features for your forged steel pipe union requirements
UNIFORM WALLS for even expansion and contraction under temperature changes. THEY FOLLOW THE PIPE!
CATAWISSA BALL-TO-ANGLE SEATS give you a "Perfect Seal" regardless of pipe alignment!
ROUND, STRAIGHT BARRELS for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!
MORE THAN ADEQUATE wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!
Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000-lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!
Get your free copy of Catalog 60 showing the complete Catawissa line . . . write direct or stop at your favorite supply store.
CATAWISSA VALVE & FITTINGS COMPANY • CATAWISSA, PENNA.
for complete, guaranteed pipe union satisfaction
. . . always specify CATAWISSA
. . . at your favorite supply store

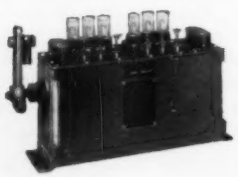
For more data on advertised products, use Readers' Service Cards, last page.

HOW FAST should you



deliver a drop of oil?

Whether you're operating high-compression diesels or fast-moving shear knives, you're probably paying more and more attention to lubrication *timing*. Whatever your field, our engineers will be glad to study your requirements and make specific recommendations. Your needs can be met either by adapting an existing model — or we will custom-build you your own lubricating system. Write for our catalog. Manzel, 256 Babcock Street, Buffalo 10, New York. You will get exact, on-time lubrication if you



ask the man from

A UNIT OF HOUDAILLE INDUSTRIES, INC.

Manzel

SPECIALISTS IN LUBRICATORS AND METERING PUMPS SINCE 1898

Suppliers . . .

public relations man with the Electro-Data Division, Burroughs Corp. for the past year. He will be responsible for preparation of material for the trade and technical press. Baker has a B.A. degree in journalism from the University of California.

ORONITE CHEMICAL CO., has named **Edward J. McLaughlin** manager, sales and product development. McLaughlin will supervise marketing, technical service and development for all the division's products. He has been with the Standard Oil Co. of California, and its research affiliate, California Research Corp., for the past 25 years. He will be headquartered in San Francisco.

McLaughlin

U. S. STEEL CORP. has appointed **R. C. Colbaugh, Jr.,** vice president, industrial engineering. A graduate of Lehigh University, Colbaugh joined U. S. Steel as a metallurgical observer at the Duquesne works in 1935.

FOOD MACHINERY AND CHEMICAL CORP.'s chemical divisions has named **Henry S. Winnicki** vice president. He was manager of FMC's Chemicals and Plastics Division. Earlier he headed the company's Central Chemical Development Department.

DELAWARE BARREL & DRUM CO., INC., is entering into a $1-million expansion program to be completed by June 1961. Delaware Barrel has recently purchased the former Pullman Co. plant, Wilmington, Del., which consists of 215,000 square feet. The expansion program is designed to increase the production and warehousing of molded polyethylene drums and tanks.

UNITED ELECTRIC CONTROLS CO. has promoted **Robert Rando** director of materials and production. Rando has been with United Electric since 1946.

HILLS-McCANNA CO. has promoted **Ralph Huft** sales promotion and advertising manager. Huft, with Hills-McCanna for the past 12 years, has previously served in various field and internal sales management capacities.

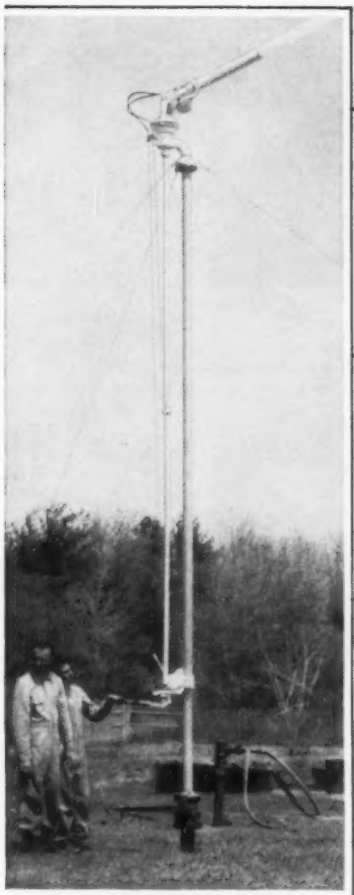
MONSANTO CHEMICAL CO.'s Overseas Division has appointed **Jan Hottinga** European sales representative at Paris, France. Hottinga previously served in the division's Marketing Department, New York.

NELSON ELECTRIC MANUFACTURING CO., Tulsa, has appointed **Paul Eldridge** Eastern Regional manager. Eldridge, who has

For more data on advertised products, use Readers' Service Cards, last page.

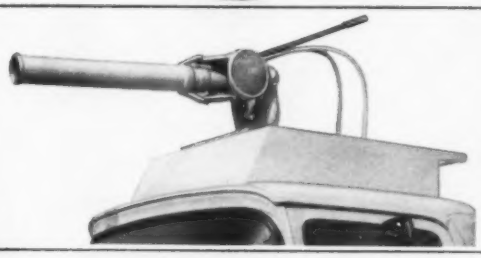
Most Complete Line of Specialty Turrets on the Market!

...All Rockwood Turrets Discharge FogFOAM
Solid FOAM Stream — WaterFOG — Solid Water Stream

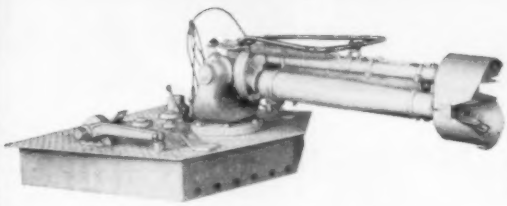


Extended Manual Control Type — Turret nozzles extend 10 to 20 feet above remote control station on deck or ground on standard units . . . greater remote extensions for special applications.

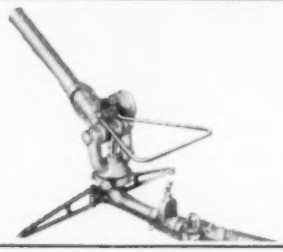
Direct Manual Control Type — Gives fire fighters "out-in-the-open" control from cab roof!



Remote Manual Control Type — Easily handled by man in driver's seat. Ideal for fast action!



Remote Hydraulic Control Type — Power-controlled from within the cab. Single and dual models. Widely used on air crash rescue fire-fighting trucks.



Portable Type — Off the truck and into action in seconds! Goes wherever a fire fighter can bring the proper hose line into action!

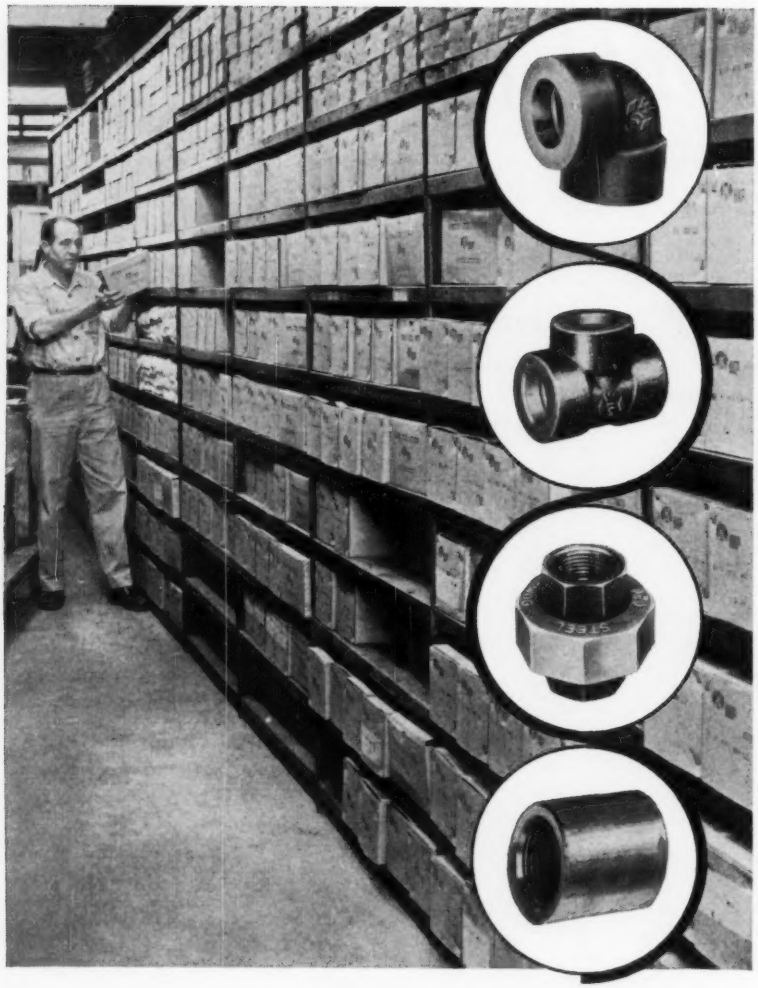
On the truck or on the ground, fire fighters can hit fires *harder* using ROCKWOOD Turrets! At airports and refineries . . . in municipalities and throughout industry . . . these advanced-design fire-fighting aids are constantly proving their ability to extinguish fires faster.

ROCKWOOD Turrets provide plenty of volume *and* versatility. What's more, all are easily adjustable on the fire line to meet changing fire conditions. Produced by the world's largest manufacturer of specialty Fire-Fighting Turrets, they're designed to give fire fighters an extra edge of efficiency on most types of fires. Get full details on the complete line of fire-fighting products. Write ROCKWOOD SPRINKLER DIVISION, Portable Fire Protection Division, 503 Harlow Street, Worcester 5, Massachusetts.

ROCKWOOD SPRINKLER DIVISION
of The Gamewell Company
A Subsidiary of E. W. Bliss Company

Engineers Water ... to Cut Fire Losses
Distributors in all principal cities.

For more data on advertised products, use Readers' Service Cards, last page.



"Off The Shelf" Deliveries for W-S FORGED FITTINGS

Inventories like these are an every-day service of W-S stocking distributors. As near at hand as your telephone.

While we're on the subject of inventories, we'd like to mention our packaging. Practically all types and sizes of fittings in any "mix" can be packed in a convenient W-S Case or Half-case . . . each type and size in its own carton.

Specify W-S on your next order. For specifications and Distributor locations, write *Forge & Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, New Jersey.*

FORGE AND PORTER FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

Suppliers . . .

spent the past 12 years in Eastern United States for General Electric Co., will make Boston his headquarters.

UNION CARBIDE DEVELOPMENT CO., division of Union Carbide Corp., has named F. R. Foote Co., Inc., Larad Industries, and W. J. Sommers Co., Inc., sales representatives in Northeastern United States for ULOK cube air filters.

Eads

Lundelius

THE PYLE-NATIONAL CO., Chicago, has appointed the Ralph Eads Co., Houston and Dallas, sales representative in Texas. **Ralph Eads,** a graduate of Texas A & M, and **O. E. Lundelius, Jr.,** a graduate of The University of Texas, will cover the territory from the Houston office. **Jack Holland,** who graduated from Texas A & M, will handle sales from the Dallas office. All three men have had experience in the electrical industry and are well known as sales representatives and field engineers in Texas.

Holland

FALCON ALARM CO., INC., has named **Frank S. Drake** director of marketing. Drake replaces **Charles P. Sagar,** formerly vice president, who has resigned. Drake was previously with the Advertising Department, Colgate Palmolive Co. He will be in charge of all sales and promotion for Falcon.

A. M. BYERS CO. has appointed **A. N. Voripaieff** New York Division manager. Voripaieff, who retains his position as Byers International Division manager, succeeds **Victor C. Lawrence.**

ALLIED METAL HOSE CO. has elected **Fredric R. Cahn** director of sales. Cahn joined Allied Metal Hose in 1950. As director of sales, he will coordinate advertising, promotion, public relations and sales engineering.

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO. has named **Howard S. Gleason** vice president, manufacturing. He was formerly

Here's Why Oil Men Specify
EC&M HIGH VOLTAGE STARTERS

2200-4800 Volts
Totally Oil-Immersed

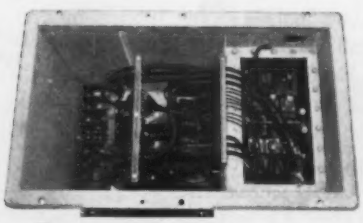
EC&M Type ZHS Starters at Southwestern pipe line trunk station

Designed for Easier Installation, Inspection and Maintenance

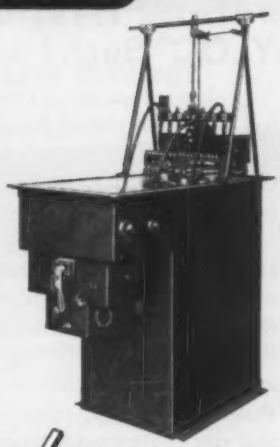
Specifically designed for Class I, Group D, Division 2, semi-hazardous locations . . . NEMA 3R (raintight enclosure). 50,000 KVA interrupting capacity.

***Fast* Installation** because starters are shipped with all internal wiring complete. All leads are of anti-syphon construction.

Easy Inspection • Contactor and overload relay panel may be raised, as one unit, above oil level. No disconnecting of bolts or leads. *(See lifting mechanism at extreme right.)* Safer, too . . . note view windows on each side of load-break disconnect switch.



View from above shows complete internal wiring . . . anti-syphon leads. These "ready-to-use" starters are complete with control transformer for 220 volt push button operation.



EC&M Contactor lifter raises contactor and overload relay above oil level for easy inspection. No bolts or leads to disconnect.

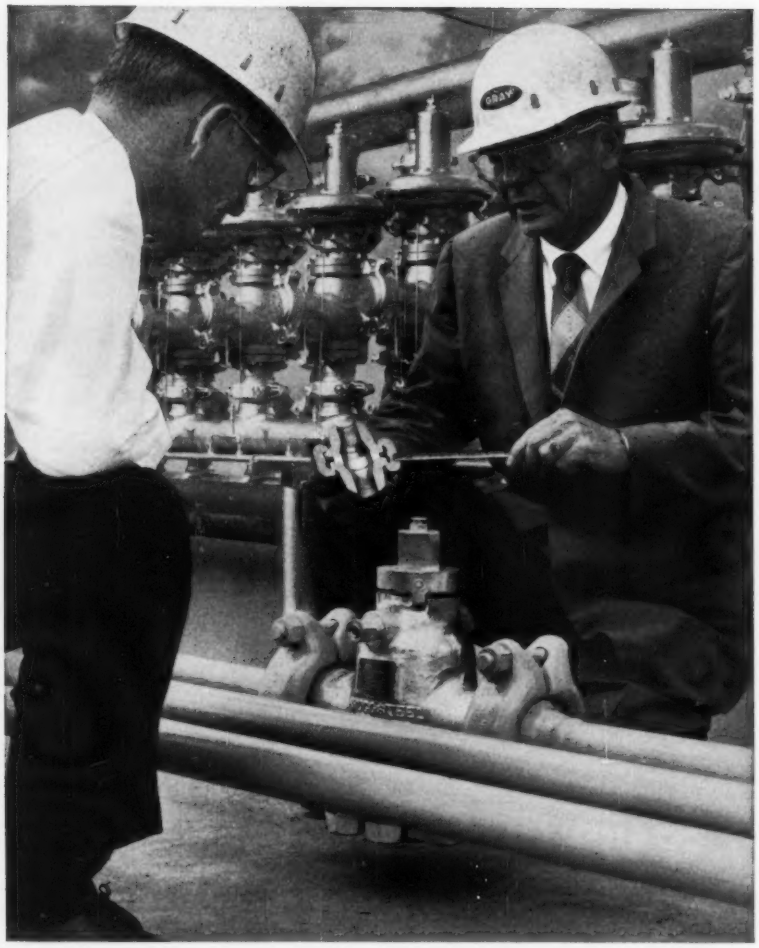
For literature describing EC&M's complete starter line, write for Bulletin 8131-T

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

8020



GRAYLOC® Seal: Leak-proof at any pressure

Leak-proof quality of GRAYLOC Seals in piping applications has been use-proved from full vacuum to 30,000 psi and test-proved up to 150,000 psi. Holding at any pressure makes GRAYLOC practical in applications requiring positive leak-proof connections.

The GRAYLOC Seal is available in two-bolt clamp-type or conventional flange connections. Its simple steel design features a rigid rib with lips on either side tapering slightly less than the mating hub to form a line seal at the touchpoint. As the connection is tightened, the lips deflect to form a surface seal. GRAYLOC connections provide a permanent steel seal that can be made up repeatedly, operating to pressure without seal ring replacement. Stock connections available from ½" to 30" and on special order in corrosion-resistant metals.

If you want to know more about how GRAYLOC Connections can permanently solve your leakage problems, write for the new GRAYLOC CATALOG on your company letterhead.

GRAYLOC SALES DIVISION

GRAY Tool Company

P. O. BOX 2291 HOUSTON 1, TEXAS Riverside 7-1240 05

Suppliers . . .

assistant to the president. **John C. Black, Jr.,** has been promoted to manager, Field Service Department. Black was with Federal Electric Corp. before joining SIE.

PARKER SEAL CO. has appointed **George Meyer** manager of manufacturing. Meyer joined Parker Seal in January 1959 from Warner & Swasey, Inc., where he was general superintendent for 12 years.

WOLVERINE TUBE DIVISION has appointed **J. P. Moore** sales representative in the San Francisco district, covering the Pacific Northwest area. Moore joined Wolverine Tube in 1957 as sales representative in the Kansas City area. Moore's territory will include the states of Washington and Oregon. He will make his headquarters in Seattle, Wash. He will continue selling the division's copper, copper alloy, and aluminum tube and extruded aluminum shapes.

Moore

COMPUTER SYSTEMS, INC., has appointed Datronics, Inc., sales representative in Texas, Louisiana and New Mexico. Datronics will handle CSI's DYSTAC high-speed analog computers, in-line control analog computers, electronic multipliers, diode function generators and the automatic digital recording and control system.

ACF INDUSTRIES, INC., has appointed **Lawrence H. Stanley** manager of marketing services. An industrial marketing consultant for the past five years, Stanley was co-founder and executive vice president of Case-Stanley Marketing Consultants, Inc. In his new post he will handle the development and coordination of marketing activities of ACF's six operating divisions.

DAYSTROM, INC., has named **Louis H. Aricson** vice president, human relations. Aricson will have charge of executive development, industrial relations, public relations, and advertising. He was vice president and general manager of Daystrom's Transicoil Division, Worcester, Pa., before his appointment.

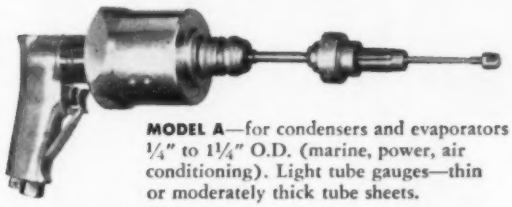
DIAMOND ALKALI CO. has named **Robert G. Dow** field salesman, Chicago branch sales office. Dow graduated from Tufts College, Medford, Mass., in 1951 with a B.S. degree in chemistry. He joined Diamond in 1955 as a technical serviceman in the Research Department, Painesville, Ohio.

HEYDEN CHEMICAL DIVISION's Philadelphia-Wynnewood sales office has appointed **Robert J. Keltz** district manager.

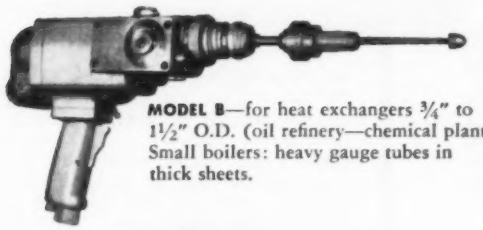
Now for every tube . . . every size . . . every type of job

WILSON
TORQ-AIR-MATIC
AUTOMATIC EXPANDER DRIVES AND ACCESSORIES

WILSON offers a complete line of Torq-Air-Matic automatic tube expander drives and torque controls. Wilson was the first to successfully develop an air driven tube expander drive that accurately controls tube expansion, by directly measuring torque output at the mandrel, without depending on frictional, ratcheting, magnetic, hydraulic or electrical devices. Hundreds are in successful use by many manufacturers and repair men the world over.



MODEL A—for condensers and evaporators ¼" to 1¼" O.D. (marine, power, air conditioning). Light tube gauges—thin or moderately thick tube sheets.



MODEL B—for heat exchangers ¾" to 1½" O.D. (oil refinery—chemical plants). Small boilers: heavy gauge tubes in thick sheets.

TUBE EXPANDERS—Wilson Models 41 and 44 Self-Feeding Tube Expanders are modern tube expanders for the *precision rolling* of condenser and heat exchanger tubes into the heavy tube sheets used in current practice.

TUBE CUTTER—Rugged and economical for use with a portable drill, for cutting off tube beyond the tube sheet.

TUBE PILOT—New Guide-Rite plastic guide inserted into tube end for easing tubes through sheet and support plates.

TUBE KNOCKOUT TOOLS—For hand or mechanical use.

Write for comprehensive Catalog 77-88.

Representatives in principal cities

THOMAS C. WILSON, INC.

21-11 44th Ave., Long Island City 1, N. Y.
Cable Address: "Tubeclean," New York

TW902 **WILSON**

BETTER TOOLS FOR BETTER WORK

As ***SIMPLE*** *and Dependable as the Pull of a* ***MAGNET!***

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

The Simplest, Most Versatile LIQUID LEVEL CONTROL Ever Devised!

Linked to liquid level by infallible magnetic force, Magnetrol is free from the limitations inherent in mechanical or electrical controls. With the actuating magnet rated at 98% of initial strength after 30 years, Magnetrol has *infinite operating life,* with practically no maintenance at all. There are no wearing parts to get out of order.

What's more, Magnetrol's simple operating principle permits easy, economical modification of standard units to meet *any* pressure, temperature or corrosion requirements. That's why there's practically no limit to Magnetrol's use. It's also why "specials" are likely to be standard with us. Magnetrol units control level changes from .0025-in. to 150-ft. —with single or multi-stage switching.

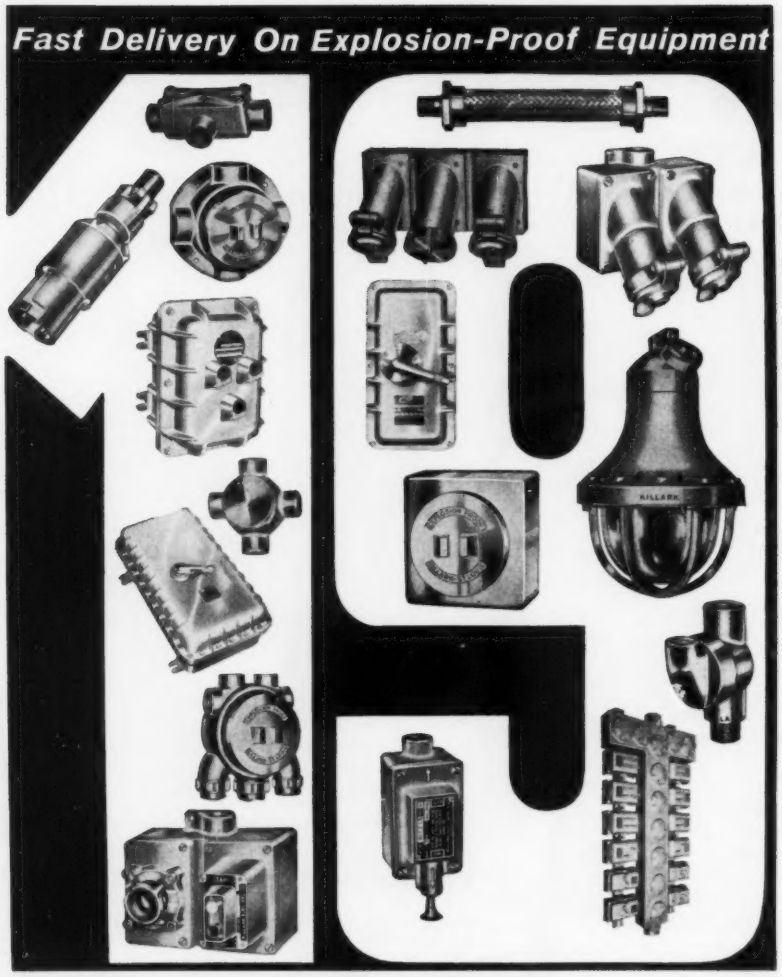
MAGNETROL, Inc.

● SEND COUPON FOR DETAILS

MAGNETROL, Inc., 2112 S. Marshall B'vd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls. 5

Name_____
Company_____
Address_____
City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.



...nineteen convenient Killark warehouses deliver explosion-proof fittings and fixtures promptly!

Regardless of where you are located in the United States or Canada, there's a Killark warehouse nearby with a complete line of aluminum explosion-proof electrical fittings and fixtures, U.L. or C.S.A. approved. Your Killark wholesaler probably has the item you need in stock or can get it for you quickly because his stock is backed up by nearby factory warehouse stocks in nineteen locations to assure you fast delivery.

Killark representatives & warehouse stocks

*Atlanta, Ga.
Ernest T. Loyd, Inc.
Baltimore, Md.
Eastern Sales Co.
*Boston, Mass.
Electrical Agencies, Inc.
*Buffalo, N. Y.
Eberhardt Electric Sales
*Chicago, Ill.
Jack L. Rowe & Son
*Cincinnati, Ohio
Arthur L. Ehlers Co.
*Cleveland, Ohio
Lusty-Thomson Co.
*Dallas, Tex.
Geo. E. Anderson Co.
*Denver, Colo.
Kenneth B. Schumann Co.
*Detroit, Mich.
Riecher Electric Sales Co.
Kansas City, Mo.
Wm. B. Terry Organization
*Los Angeles, Calif.
Kenneth Anderson Co.
Milwaukee, Wisc.
Martin-Gaertner Sales, Inc.
Minneapolis, Minn.
Harry P. Smith Co.
New York City, N. Y.
W .J. Wickenheiser Co.
Omaha, Neb.
Walter C. McConkie
c/o Power Equipment Co.
*Philadelphia, Pa.
Harry G. Anschuetz Co.
*Phoenix, Ariz.
Kenneth Anderson Co.
Pittsburgh, Pa.
Crescent Sales Co., Inc.
Richmond, Va.
W. E. Sullivan, Jr.
*San Francisco, Calif.
F. M. Nicholas Co.
*Seattle, Wash.
Northwestern Agencies, Inc.
*Edmonton, Alberta
A. H. R. Louden Agency
Regina, Saskatchewan
Douglas G. Morton
c/o MacKay-Morton, Ltd.
*Toronto, Ontario
Killark Electric of Canada
*Vancouver, B. C.
Griffon Sales Ltd.
*Winnipeg, Manitoba
MacKay-Morton, Ltd.
Montreal, Quebec
Harry J. Issenman
Rothesay, N. B.
Lloyd G. Dykeman
*Warehouse Stocks

6008

Killark
ELECTRIC MANUFACTURING CO.
Vandeventer and Easton Aves. • St. Louis 13, Mo.
In Canada: Killark Electric of Canada, Ltd., 421 Islington Ave., South Toronto, Ontario

Suppliers . . .

Keltz has been in technical service and sales activities in the chemicals processing industries for the past 10 years. He joined Heyden in 1956 as a sales representative, Newark sales office.

SELAS CORP. OF AMERICA has appointed **Jack J. Kerns** director of purchasing. Kerns will serve in purchasing engineered and technical materials, equipment and services in addition to his duties as head of the Purchasing Division. He has been with Selas since 1935. He is a licensed professional engineer in Pennsylvania. He has served the company in the Electrical Department, as plant engineer, service manager and assistant works manager.

Kerns

CONOFLOW CORP. has named **Raymond F. Neill, Jr.,** purchasing agent. Neill joined Conoflow in 1956 as a production planner. In 1958, he was made a buyer, which he has been until his present appointment.

MINNEAPOLIS-HONEYWELL REGULATOR CO., Brown Instruments Division has named **William B. Shellenberger** manager of the Planning and Procurement Department. Shellenberger, who joined Honeywell in 1952 as an administrative assistant, organized and was first manager of Brown Instruments' parts depot.

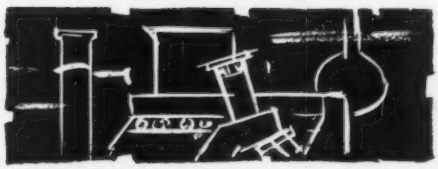
INTERNATIONAL CONTROLS CORP. has named **Terry W. Russell** vice president of sales and a member of the board of directors. Russell was one of the original members of the Automation Division formed by Dresser Industries where he was primarily interested in market research and sales.

CELANESE PLASTICS CO., a division of Celanese Corp. of America, has appointed **Edward W. Ward** vice president and director of marketing and **Frank B. Cameron** vice president and manager of manufacturing. Ward has been director of marketing for Celanese Plastics since June 1958. Cameron has been production manager of the Amcelle plant of Celanese, Cumberland, Md.

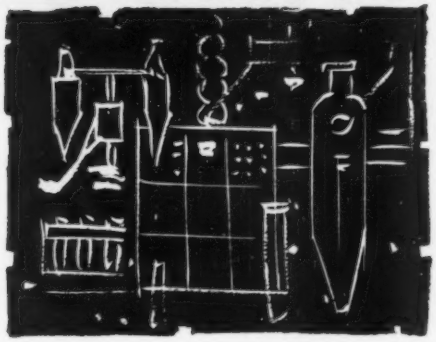
UNITED STATES STEEL CORP.'s American Bridge Division has appointed **R. A. Shaw** vice president of manufacturing operations. Shaw started with American Bridge Division in 1926 as a clerk in the division's Ambridge, Pa., plant.

INLAND STEEL CONTAINER CO., a division of Inland Steel Co., has named **S. Robert Brower** laboratory director. Brower will be in charge of all the division's chemical

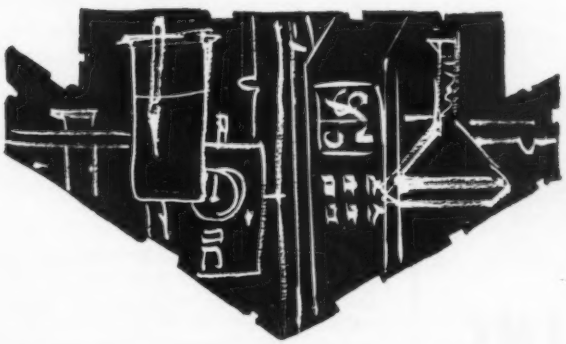
For more data on advertised products, use Readers' Service Cards, last page.



EVERYTHING FOR THE PETROLEUM LABORATORY



Curtin's conveniently located warehouses throughout the South and Southwest have everything for the petroleum laboratory in stock and ready for immediate delivery. Repair service and technical assistance are always available to Curtin customers. Save time and money by ordering all your laboratory requirements from Curtin, where complete stocks and facilities assure you of the best service.



W.H. CURTIN & CO.

PETROLEUM TESTING EQUIPMENT

CURTIN

HOUSTON • DALLAS • TULSA • NEW ORLEANS
JACKSONVILLE • BIRMINGHAM • CORPUS CHRISTI
CURTIN DE MEXICO, S. A. DE C. V., MEXICO, D. F.

112

ENGINEERING PERSPECTIVE THROUGH A

VENTURI

Venturi tubes were first used for measuring fluid flow. While this application has increased substantially, the use of the Venturi in important unit process operations has increased even more. A Jet-Venturi combination is literally the heart of many important manufacturing processes.

JET REFRIGERATION
JET COMPRESSORS
JET CONDENSERS
JET HEATERS
JET PUMPS
JET MIXERS
JET REACTORS
JET ABSORBERS
JET FUME SCRUBBERS
SPECIAL JET VENTURI UNITS

During the first several years of the forty-two year history of our firm, we specialized entirely on steam jet vacuum pumps (ejectors). Many thousands of these are in service throughout the country and in most foreign countries. Our tradename, EVACTOR, is an important word in engineering circles. While steam jet vacuum pumps are still our major item, other applications of Jet-Venturi equipment are increasing constantly. With the exception of closely related products such as barometric condensers, CHILL-VACTORS, and CONVACTOR* systems, all of our activity is directed to the one purpose of making Jet-Venturi units more efficient, more dependable, more economical, and to apply them to an increasing number of industrial applications.

* The CONVACTOR is a dual condensing system for economic and efficient recovery of high boiling components from water vapor.

CROLL REYNOLDS

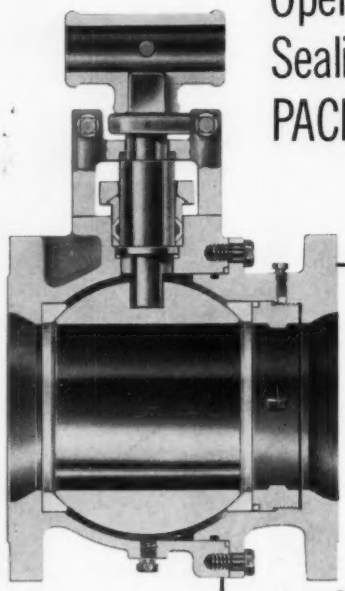
Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

Chill-VACTORS® • Steam-Jet EVACTORS® • Aqua-VACTORS® • Fume Scrubbers • Special Jet Apparatus

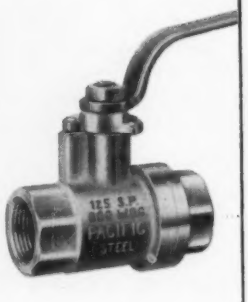
For more data on advertised products, use Readers' Service Cards, last page.

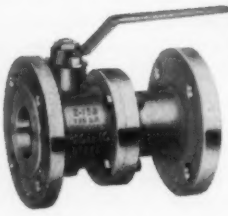
Quick Quarter-Turn Operation and Positive Sealing Featured in PACIFIC's **New** BALL VALVES



Pacific's new Ball Valves utilize elastomer seals and a unique floating ball design for absolute tight closures with line flow in either direction. Straight through, round ports promote efficient handling of slurries, semi-solid fluids and abrasive loaded fluids or gases. Hard, mirror finish of ball improves corrosion resistance and affords a low coefficient of friction. Quick, quater-turn operation assures responsive, immediate full open or full closed positioning. Versatile valve handle can be installed in two positions for convenient operation even in the most confined quarters. Lightweight, compact design reduces installation cost and valves can be easily installed in any positon.

Pacific offers a wide range of standard materials to custom-tailor these valves to fit your particular application without delivery delay or extra expenses. Available in sizes ¼" to 10". Pacific can meet your immediate needs with valves of Ductile Iron, Cast Iron, Bronze, Aluminum, Alloy Steels and Carbon Steel.





Write for Bulletin BV-60

PACIFIC VALVES, INC.

3201 WALNUT AVE. LONG BEACH, CALIF.

Sales Offices in Most Principal Cities with Complete Valve Reconditioning Facilities in Houston, Texas; Woodbury, New Jersey; and Chicago, Illinois.

Suppliers . . .

research and development including work on interior and exterior coatings for steel shipping containers. He graduated from Purdue University.

Koons

Griffin

JOHN ZINK CO., Tulsa has appointed **John J. (Jack) Griffin** to head the Industrial Sales Division and **Harold F. Koons** sales manager. Griffin was formerly chief engineer for National Airoil Burner Co. eight years, and was with Petro-Chem Engineering Co. six years. Koons was with the Refinery Engineering Co. before joining the Zink Co.

LEEDS & NORTHRUP CO. have announced plans to set up two branch offices at Dallas, Texas, and East Chicago, Ind., and four residencies at Syracuse, N. Y., Minneapolis, Minn., San Diego, Calif., and Phoenix, Ariz.

GENERAL MILLS, INC.'s Chemical Division has appointed **Ronald Sundberg** sales representative, Kankakee, Ill., general office. Sundberg, who graduated from Northwestern University, was with Procter and Gamble and American Mineral Spirits Co. in sales before joining General Mills.

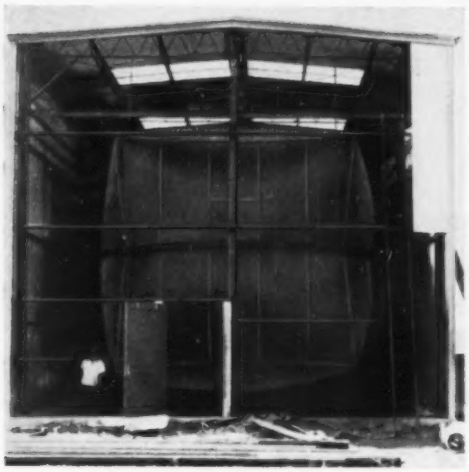
IMPERIAL BRASS MANUFACTURING CO.'s Frederick C. Shafer, chairman of the board, has announced that Imperial Brass and Eastman Manufacturing Co. have merged.

PANELLIT, a division of ISI, Inc., has named **Alfred E. Miller** sales application engineer, Baton Rouge, La., office. Miller is a registered professional engineer, ISA member and a graduate of Southwestern Louisiana Institute.

OAKITE PRODUCTS, INC., has assigned two representatives to the field service staff. **Lon E. Welch,** representative in Akron, Ohio, since 1956, has been transferred to Kokomo, Ind., **George E. Park** has been reassigned to Springfield, Mo.

ESCAMBIA CHEMICAL CORP. has employed **Dr. Earl W. Lane** as manager, new product development, Commercial Development Department. Dr. Lane will have his headquarters in New York. He

BIG SAVINGS WITH LOW-COST REEVES-VULCAN BREATHER BALLOONS



Stop vapor loss with this air-tight, self-contained, completely closed system.

Now—with a low-cost Breather Balloon installed in new or modified storage systems, you can capture the vapors that might otherwise be lost during the storage or transfer of volatile liquids. Reeves-Vulcan Breather Balloons require no skilled labor to install, no high priced housing . . . cost practically nothing to maintain.

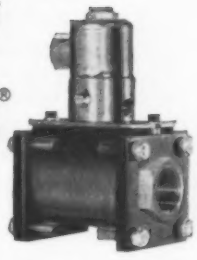
Ultra-high strength neoprene-coated nylon gives these rugged balloons unusually long life. Every Breather Balloon installed is still in use, still returning profits. Make your storage tank a closed system . . . install Reeves-Vulcan Breather Balloons—the most efficient and most economical system of vapor conservation ever developed for low to medium storage volume.

For free, informative brochure, write to: Reeves Brothers, Inc., Vulcan Rubber Products Division, 1071 Avenue of the Americas, New York 18, New York.

REEVES VULCAN

Reeves Brothers, Inc., Vulcan Rubber Products Division
1071 Avenue of the Americas • New York 18, New York

New Revolutionary Tube-O-Matic® Valve



SQUEEZE-ACTION makes the difference—controls air, oil, chemical and even grinding slurries.

No poppets, no spools, no metal-to-metal contacts and no metal-to-rubber seals.

No wear and tear—and no need for repair.

See it:
Chicago, PES Show, Sept. 6-16, Booth 483
Los Angeles ASTE Tool Show, Nov. 14-18, Booth 547

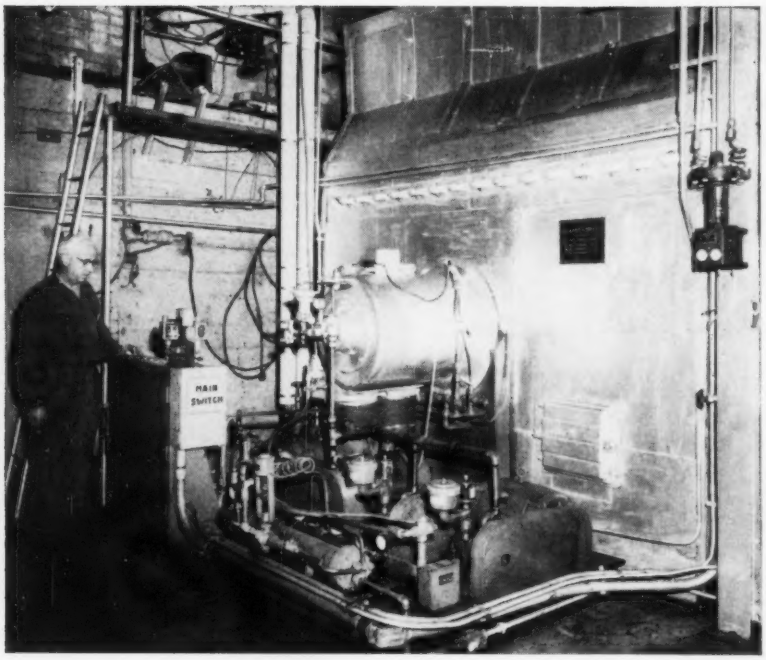
Or read about it: Write for Bulletin 91043
AX-29

TUBE-O-MATIC®

AIRMATIC® valve, inc.

7313 Associate Ave., Cleveland 9, Ohio

Phone: WOodbine 1-5320 • WESTERN UNION: Airmatic Valve, Inc., FAX, Cleveland, Ohio



No Fuel Burning System Can Match O & S for Efficiency

Superiority of O&S burner systems can be demonstrated by these facts:

1. **Extraordinary Fuel Savings**—Impressive fuel savings are provided at *all* firing rates. Savings often pay for investment in a matter of months.
2. **Efficiency**—Higher *guaranteed* burner efficiency over a *wider* turndown rate than any other burner system.
3. **Performance**—O&S burner systems outperform all other assemblies. 5 to 1 turndown *without increase in excess air ratio is* widest in industry. Combustion air, accurately controlled, plays *no* part in atomization.
4. **Dependability**—No moving parts exposed to high temperatures. No tiny orifices to clog or distort.
5. **Flexibility**—Complete units for any commercial grade of fuel oil, any commercial gas (including sewer gas.) Air atomizing or steam atomizing.
6. **Typical Results**—A major New York State manufacturer is effecting a labor saving at the rate of $40,000 annually. (Name on request.)

Want more proof? We have an impressive array of case histories and performance data that are eye-openers. You owe it to yourself to investigate this outstanding burner system. Write for Bulletin 1255.

ORR & SEMBOWER, INC.

World Leader in Packaged Boilers and Burners

710 Morgantown Road, Reading, Pa. • Since 1885

Suppliers . . .

obtained his B.S. degree from the University of Illinois and his doctorate in organic chemistry from the University of Colorado.

GENERAL RUBBER CORP. has named **Arthur F. Becker** vice president in charge of manufacturing and **Robert L. Swenson** vice president in charge of engineering. Becker has been with the corporation since its beginning and has held executive positions in both the engineering and manufacturing divisions. Swenson was formerly chief engineer of the firm.

ACHESON COLLOIDS CO., Port Huron, Mich., has appointed **Donald M. Conroy** sales representative for the Northern Ohio territory. Before joining Acheson, Conroy was a salesman for the Fabrics and Finishes Division, E. I. du Pont de Nemours & Co. He graduated from John Carroll University and attended the University of Washington. Conroy will make his headquarters at Cleveland, Ohio.

Conroy

CONSOLIDATED SYSTEMS CORP. has appointed **Baron C. Whitney** Western Regional sales manager. Before joining Consolidated Systems in 1958 as field engineering representative and resident manager, San Diego, Calif., Whitney was logistics representative for Convair Astronautics.

THERMO ELECTRIC MANUFACTURING CO. has changed its corporate name to Thermolyne Corp. The corporation will continue to manufacture furnaces, temperature controlling and indicating instruments and laboratory hot plates under the Temco and Thermolyne trademarks.

CONSOLIDATED ELECTRODYNAMICS CORP., a subsidiary of Bell & Howell Co., has elected **Richard W. John** assistant secretary. John, formerly assistant to the secretary and assistant corporate attorney at Bell & Howell, will serve CEC primarily as its legal officer.

KAISER INDUSTRIES CORP. has appointed **George Havas** vice president and director of engineering. Havas joined Kaiser in 1928 as an office engineer and later served as a vice president in the Henry J. Kaiser Co.

PERKIN-ELMER CORP., Norwalk, Conn., has completed arrangements for instrument users to lease chemical analytical instrumentation with Horton Equipment Leasing Division, Advance Industries, Inc., Cambridge, Mass. Under the plan,

For more data on advertised products, use Readers' Service Cards, last page.

RASCHIG RINGS

Metal RASCHIG Rings For Tower Packing

Sizes 3/8" thru 3"
IN STEEL, ALLOY OR OTHER METALS

SEE OUR CATALOG IN REFINERY CATALOG
OR SEND FOR A COPY

Where Your Refining, Petro-Chemical, Natural Gasoline Process Requirements Call for Tower Packing

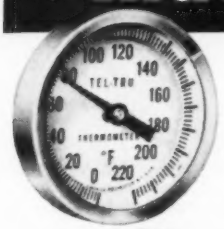
CALL BRAZZIL TOOL & DIE SHOP

Telephone: HOmestead 8-3333
P. O. Box 19034 HOUSTON 24, TEXAS

TEL-TRU DIAL THERMOMETERS

18-8 STAINLESS STEEL

Industrial



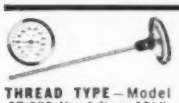
All popular Dial Ranges Fahrenheit or Centigrade

THREAD TYPE—Model GT-300R with recalibrater. Anti parallax dial avoids reading errors. Actuated by super sensitive bi-metallic helix coil—no liquids. Guaranteed accurate within 1% around entire dial range. Head diameter 3". Standard ½" N.P.T. stainless steel connecting nut. Stem 2½" to 72" long x .250" diameter. Measurements include thread. Also available without recalibrator as Model GT-300.

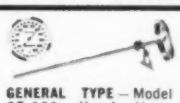
SEND FOR FREE LITERATURE
MANUFACTURER'S AGENTS WANTED

TEL-TRU MANUFACTURING CO.
902 St. Paul Street, Rochester, N. Y.

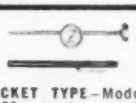
Subsidiary of Germanow-Simon Machine Co., Inc.



THREAD TYPE—Model GT-200. Head diam. 1¾". Standard ⅛" & ¼" N.P.T. stainless steel connection nut. Stem: 2½" to 18" long x .150 diam. Measurements include thread.



GENERAL TYPE—Model GT-100. Head diam. 1¾". Stem 5"-8" long x .142" & .150" diam. Adjustable vessel clasp. Manual preset indicator for marking temperature.



POCKET TYPE—Model PT-50, service man's spot check. Head diam. 1". Stem 5" long x .150 diam. Hard rubber pocket case.

PARKINSON COWAN INDUSTRIAL PRODUCTS

GAS TEST METERS

with 150 years of experience in the measurement of gases

Parkinson Cowan gas test meters are world renowned as products of master craftsmen. Every Parkinson Cowan instrument represents the 150-year tradition of high accuracy and fine workmanship.

These Parkinson Cowan volume test meters are of the wet-type, which contain a drum with a horizontal axis that rotates more than half immersed in water, thus providing a greater control of accuracy. Each instrument is easily dismantled for cleaning and servicing. You can rely on a PC gas test meter to provide years of true test measurement.

TYPE A	TYPE B	TYPE E-40
Compact Test Meter With Large Capacity	Portable Test Meter For All Laboratory Work	Heavy Duty Type For Oil & Chemical Use
Capacity: 20 cu. ft./hr.	**Capacity:** 10 cu. ft./hr.	**Capacity:** 40 cu. ft./hr.
Accuracy: ±0.1%	**Accuracy:** ±0.25%	**Accuracy:** ±0.25%
Case: Tinned brass	**Case:** Plated Copper	**Case:** Stainless Steel
Dim.: 11" h, 11" w, 12½" d	**Dim.:** 11" h, 11" w, 12½" d	**Dim.:** 13" h, 15" w, 15" d
Wt.: 23 lbs.	**Wt.:** 10 lbs.	**Wt.:** 18 lbs.
Connections: Elbow for push-on tubes; internal thread—⅜"	**Connections:** Push-on rubber tubes; internal thread—⅛"	**Connections:** Push-on ¾" tubing
Price: $275.00	**Price:** $185.00	**Price:** $250.00

For further details, and Parkinson Cowan catalog, covering both wet and dry type test meters, contact:

INSTRUMENTATION ASSOCIATES
17 W. 60th St., New York, N. Y., Circle 5-5590

For more data on advertised products, use Readers' Service Cards, last page.

AIRETOOL stands up under torture

Yes sir! You can depend on Airetool for speed, accuracy and economy in tube maintenance

Airetool pneumatic tools—cleaners, drills, brushes and motors—are designed to meet the specific needs of refiners for efficient, low-cost tube maintenance and to do the job under the most difficult conditions.

For example, the AIRETROL Tube Expansion Control, illustrated at right, rolls up to 12 tubes a minute within .001 inch accuracy; maintenance costs drop and expensive tube failures are reduced. Labor costs are cut, too, because Airetrol's rugged, lightweight construction makes one-man operation easy.

And, one man can remove the hardest deposits and clean completely plugged tubes with Airetool's CC-475 Condenser Cleaner. The built-in flushing system keeps the drill cool and the cuttings washed away.

CC-475 CLEANER

If you're plagued by high tube maintenance costs, investigate the economies of Airetool tube equipment; it puts you on stream sooner and keeps you there longer. For full information write to:

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
Representatives in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
CANADIAN PLANT: Brantford, Ontario.
EUROPEAN PLANT: Vlaardingen, The Netherlands.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

More than 30 years' experience in pneumatic tools

Suppliers . . .

instrument users may lease Perkin-Elmer instruments at a nominal monthly rate for each thousand dollars of the equipment's purchase price.

CLIMAX MOLYBDENUM CO. has appointed **James T. McCabe** lubricant development engineer. He previously had served as a sales engineer with Cities Service Oil Co. for 14 years, and in the Sales Department, L. Sonneborn Sons, Inc., petroleum refining company.

DASHEW BUSINESS MACHINES, INC., has named **John H. Humphrey** vice president, management, engineering and planning. Humphrey was director of management engineering projects of RCA, New York, before joining Dashew. Prior to joining RCA, Humphrey headed his own electronic data processing consulting firm. He graduated from the University of Michigan. During World War II, he was a U.S. Navy reserve management engineering officer.

Humphrey

KEASBEY & MATTISON CO. has appointed **D. W. Frasier, Jr.,** merchandising manager, asbestos paper, millboard, and electrical insulating products. Frasier was formerly with Standard Asbestos Manufacturing & Insulating Co. He attended the University of Minnesota's Institute of Technology.

THE CARPENTER STEEL CO. has named **C. Donald Steinwedel** manager, warehouse operations. Steinwedel was in sales work at Carpenter's Alloy Tube Division and plant superintendent at the Union, N. J., plant. He was a sales engineer with B-R Engineering Co. prior to joining Carpenter.

CHASE BRASS & COPPER CO., a subsidiary of Kennecott Copper Corp., has appointed **John F. Van Landeghem** Eastern Regional sales manager. **Thomas E. Cox** has been named district sales manager, Waterbury, Conn.

JEFFERSON CHEMICAL CO., INC., has appointed **James V. Daniels** salesman for the Eastern Region. Daniels is a graduate of Texas Technological College and has an M.B.A. degree from Harvard Business School. Before joining Jefferson Chemical, he was employed at the Houston and New Orleans offices of Shell Oil Co.

HAVEG INDUSTRIES, INC., has appointed **Dr. Ernest O. Ohsol,** vice president of chemical operations. Dr. Ohsol comes to Haveg Industries from Pittsburgh Coke and Chemical Co. where he was direc-

FLUID & GAS PRESSURE TANKS

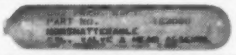
STAINLESS & CARBON STEEL TANKS

(GOVERNMENT SURPLUS BARGAINS)

Steel tanks for the handling, storage and transportation of gases, beverages, fuels, hydraulic fluids and other liquids. Stainless steel tanks for corrosive acids and gases.

J-1 PRESSURE TANK Stainless steel, surplus aircraft oxygen tank. 48" long, 24" dia. Rated for 400 P.S.I. working pressure, 18,000 cu. in. vol., 77.9 gal. capacity. ¼" pipe thread fitting at each end. New condition. Shipping weight 247 lbs. F.O.B. Chicago.
No. AH832 ..... $99.50

G-1 TANK Stainless steel. Capacity 2100 cu. in. (9 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 12" dia. Shipping weight 19 lbs. F.O.B. Chicago. (Two for $27.00.)
No. AH63 Each $14.95



NON-SHATTERABLE CO_2 CYLINDER This type of pressure bottle was used by the Armed Forces for inflating life rafts. 18¼" long, 3¾" dia. Has ½" pipe thread opening at one end. Capacity 2.98 lbs. of CO_2—at 1800 P.S.I. Shipping weight 10 lbs. F.O.B. Chicago.
No. AH303 ..... $2.50

FREON TANK Capacity 22 oz. of Freon F22, 6 cc Methyl Alcohol. 18¼" long, 2" dia. ¾" pipe thread opening at one end. Equipped with brass valve. Shipping weight 3 lbs. F.O.B. Chicago. (Six for $8.00).
No. AH834 Each $1.50

D-2 AIR TANK Carbon steel. Capacity 500 cu. in. (approx. 2 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 6" dia. Postpaid. (Two for $8.50).
No. AH391 Each $4.95

CORNELIUS HIGH PRESSURE (1500-2000 P.S.I.) AIR COMPRESSOR Three cylinder, 3-stage compressor, complete with 27 volt, D.C. 20 amp. motor, with fan. Rated 1500 P.S.I. continuous duty, 2000 P.S.I. intermittent. Pressure switch in base. As released by Air Force, in used, serviceable condition. Covered by our 30 day GUARANTEE. 11½" long, 7" high, 9" wide. Shipping weight 12 lbs. F.O.B. Chicago. Limited quantity.
No. AH549 ..... $35.00

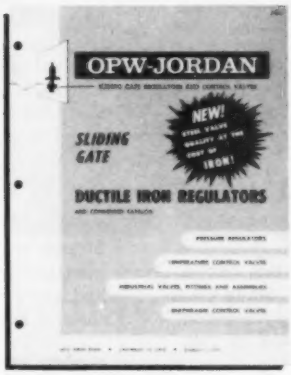
Write today for FREE CATALOG of other EQUIPMENT BARGAINS!

GROBAN SUPPLY COMPANY

• 1139 SOUTH WABASH AVE., DEPT. AH-9, CHICAGO 5, ILL., WEbster 9-3793 •

NEW

REGULATORS AND CONTROL VALVES NOW AVAILABLE IN DUCTILE IRON



This easy to use manual describes how you can get steel strength in regulators and control valves at the cost of iron . . . and, at considerable savings. It fully explains how ductile iron is produced, shows features, specifications, typical ranges of mechanical properties, and comparison tables on physical properties of cast steel, ductile iron, red brass and cast iron. This manual is also a condensed catalog describing the complete line of OPW-JORDAN products that are available to you in ductile iron. It's available for the asking . . . so, send for your Ductile Iron Manual today!

Send for your Copy!

OPW-JORDAN

6013 WIEHE ROAD
CINCINNATI 13, OHIO

DI-1

No liquid carry-over problem is ever too great for METEX!

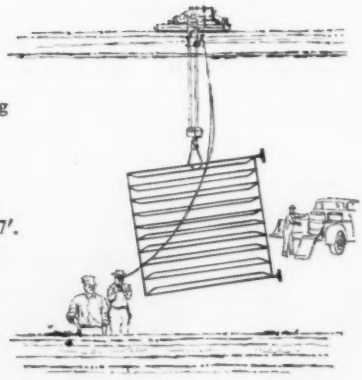
In installation after installation...in all types of processing equipment—Metex mist eliminators are knocking back liquid entrainment...upping production...improving quality...cutting operating and maintenance costs. Your particular entrainment problem is no exception. For at Metal Textile we've been knitting low-cost answers to such problems since 1943. As the originators of knitted wire entrainment separators, Metal Textile has the engineering experience—and the research and production resources necessary to support that experience—to take on even the most difficult liquid entrainment problems. Our engineering department stands ready to help you solve your particular problems with complete design assistance. For latest design guides, write or call for Bulletin ME-9: Metal Textile Corporation, Roselle, N. J.

METAL TEXTILE CORPORATION
...world's largest and oldest producer of knitted wire products
A DIVISION OF GENERAL CABLE CORPORATION

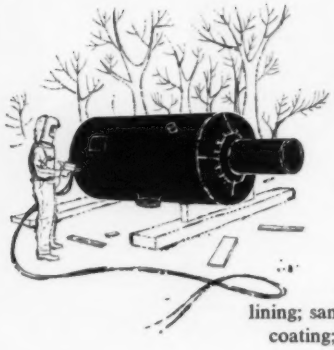
For more data on advertised products, use Readers' Service Cards, last page.

Nowery J. Smith Co. has the atmospheric corrosion prevention service you require

HOT-DIP GALVANIZING• Nowery J. Smith Co. is the most experienced galvanizer in the Southwest. Professional galvanizers assure that complex shapes, inside surfaces, and hard-to-reach areas—all—receive the same durable zinc coating. Applied according to ASTM or your own specifications.



PICKLING• For scientifically cleaning ferrous metals and stainless steel fabrications Nowery J. Smith Co. operates a complete pickling farm. Farm is equipped with seven pickling tanks in sizes up to 39′ 6″ by 3′ 4″ by 7′.



SPECIAL COATINGS • For structures and equipment requiring the protective advantages of zinc, aluminum, or other hot metal coatings, Nowery J. Smith Co. offers a complete metallizing service—applied in its plant or at your job-site. Additional special coatings and metal surface services include: Plioweld rubber lining; sand or shot blasting; painting; oiling; prime coating; epoxies and other task-tailored coatings.

When your next corrosion prevention problem arises, discuss it with a sales engineer from Nowery J. Smith Co., the Southwest's most complete corrosion prevention center. There's no obligation. Write, wire, or call:

LARGEST HOT-DIP GALVANIZERS IN THE SOUTHWEST

NOWERY J. SMITH CO.

8000 HEMPSTEAD HIGHWAY • P. O. BOX 7398 HOUSTON 8, TEXAS • UNderwood 9-1425

ONE OF THE SMITH INDUSTRIES —

Suppliers . . .

tor of research and development since 1954. He received his B. S. degree in chemical engineering from New York City College in 1936, and his doctor of science degree from Massachusetts Institute of Technology in 1939.

HOOVER BALL AND BEARING CO. has named **J. R. Brashears** to head the Hoover Ball Division. Brashears will serve as general manager of the division and **C. E. Bowman** has been appointed assistant general manager. The Ball Division consolidated all ball manufacturing, engineering, sales and administrative functions on August 1. The division's headquarters are at Middletown, Ohio.

Brashears

THE BRISTOL CO., a subsidiary of American Chain & Cable Co., Inc., has purchased Hanson-Gorrill-Brian, Inc., Glen Cove, N.Y. The business will operate under the title, The Data-Master Corp., and will retain the same management and engineering staff.

THE COOPER-BESSEMER CORP. has announced that **Stanley E. Johnson,** vice president and director of sales, has retired after 42 years of service. Johnson joined the firm in 1918, and was named assistant sales manager in 1932. He has been a director of the company since 1946, and will continue to serve in that capacity.

JOHN THOMPSON INSTRUMENT CO., LTD., has promoted **Bernard Wright,** who joined the company in June 1958 as their London representative, sales manager. Wright began his career with the South Suburban Gas Co. as an engineering apprentice. Before joining John Thompson Instrument, he was a technical representative for Dewrance & Co., London.

WALWORTH CO. has elected **Hellmuth Strauss** vice president and general sales manager. Strauss served as an executive and board member of Walworth for more than 25 years before he left in 1957.

ELLIOTT CO. has appointed **Charles L. Hoebel** Eastern Regional manager. He is presently serving as New York district manager and will continue in this capacity. Hoebel joined Elliott in 1952 as a field engineer. He was named district manager, New York territory, in 1957.

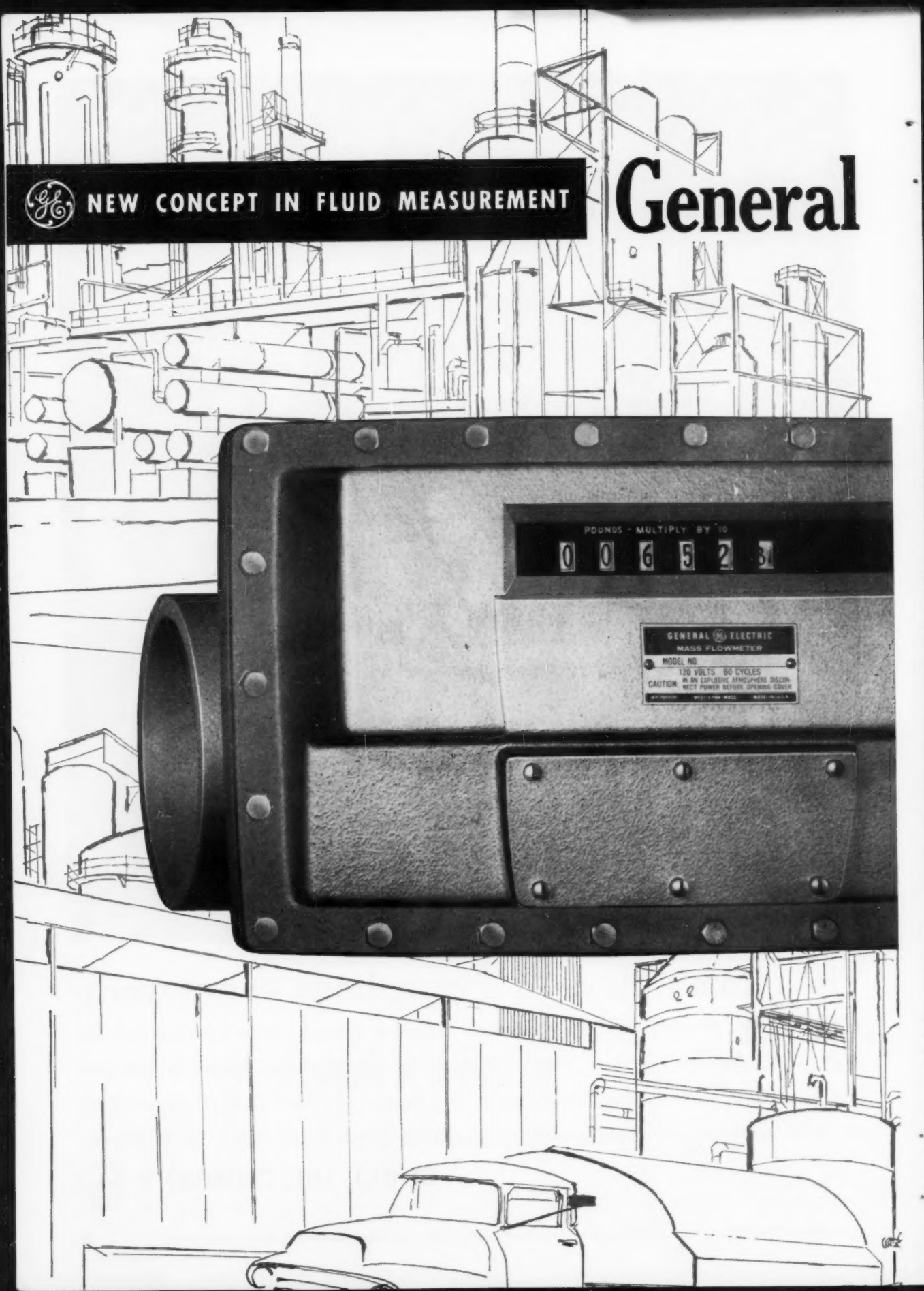
MARCUS TRANSFORMER CO. has named **Leonard J. Siegal** a director. Siegal is general sales manager of the company. He has served as advertising manager,

The oilman plays in a symphony every working day.

His skills blend with the skills of thousands of other experts to help provide the nearly 10,000,000 barrels of oil our nation demands every day. Oil to build, to save lives, to grow food. In oil-hungry tomorrow, the demands will be even greater. He'll meet them. So will you. If you should hear someone speak out against oil—tell him you're an oilman and proud of it. And tell him why.

SHELL OIL COMPANY

For more data on advertised products, use Readers' Service Cards, last page.


NEW CONCEPT IN FLUID MEASUREMENT
General
POUNDS - MULTIPLY BY 10
0 0 6 5 2 3
GENERAL ELECTRIC
MASS FLOWMETER
MODEL NO
120 VOLTS 60 CYCLES
CAUTION
IN AN EXPLOSIVE ATMOSPHERE DISCONNECT POWER BEFORE OPENING COVER

Electric Gyro-Integrating True Mass Flowmeter

ACCURATELY MEASURES FLOW OF LIQUIDS, GASES AND LIQUEFIED GASES . . . DIRECTLY IN POUNDS

This new General Electric meter provides continuous local or remote totalization and registration of gas and liquid flow by weight within ±1 percent accuracy over wide variations in flow rate, density, pressure, temperature and viscosity.

PROCESS FLOW MEASUREMENT—Ideal for applications in the petroleum, chemical, and petro-chemical industries, the new mass flowmeter completely eliminates time-consuming orifice calculations and possible costly errors in correcting volumetric readings for fluid variables. It does away with the need for recalibration when process and flow conditions change, too. And it puts an end to supercompressibility problems.

What's more, the new flowmeter lets you make complete and accurate material balances easily because it operates on a mass measurement principle and gives you your answer *in pounds*. No more measuring liquids in gallons or barrels, gases in cubic feet, then making tedious conversions in order to equate the two. Measurement of both by weight allows direct comparison.

LIQUEFIED GAS MEASUREMENT—You can measure the weight of truck and tank car loading of your liquefied gas products easier and faster with General Electric's new mass flowmeter than with present volumetric-type meters or expensive and cumbersome scale installations. The meter registers the total loaded weight directly in pounds. Then, operating from a battery-inverter power supply, the flowmeter can be used right on your truck when unloading, for easy and accurate deliveries. And no precautions are necessary to protect the meter from high velocity caused by "flashing."

An outgrowth of General Electric research into mass flow measurement, this new meter has already been proved on such fluids as natural gas, ethylene, Freon, liquid carbon dioxide, naphtha and jet fuel.

For complete sales and service information, contact your nearby General Electric Apparatus Sales Office, or write for bulletin GEA-6925A, Section 599-02A, General Electric Company, Schenectady 5, N. Y. On applications in the natural gas industry, contact Black, Sivalls and Bryson, Inc., Kansas City, Missouri.

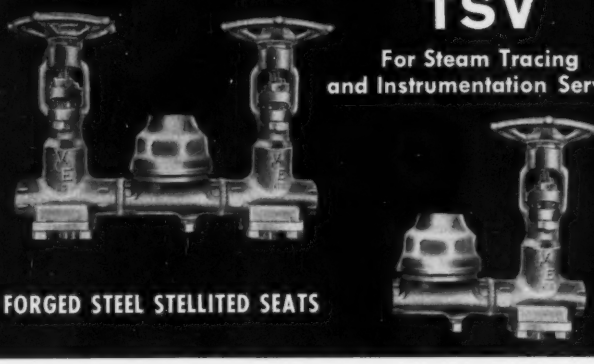
Visit General Electric's 1960 ISA Show Exhibit, "Leadership in Industrial Automation", Booths 1116-1126, New York Coliseum, Sept. 26-30.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

SPECIFY: VELAN PIPING KING TSV

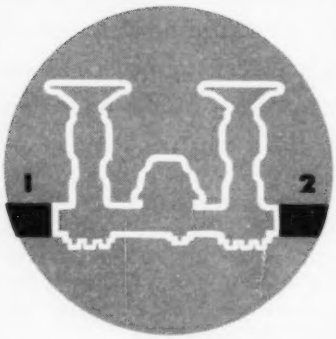
For Steam Tracing and Instrumentation Service



FORGED STEEL STELLITED SEATS

NO EXTRAS

The only complete Steam Trapping Hook-up with JUST 2 CONNECTIONS



ONLY 30 SECONDS to replace the entire steam trap

SAVE:

4 hours installation time 90%
$60.00 in cost 50%
14 fittings
19 welded and/or screwed joints.

PRODUCTS OF VELAN'S CREATIVE ENGINEERING FOR THE PETROLEUM INDUSTRY

Write to VELAN Companies in:
BEEKMANTOWN ROAD, PLATTSBURGH, NEW YORK
2125 WARD AVENUE, MONTREAL, CANADA, ROSS WALK, LEICESTER, ENGLAND

Suppliers . . .

sales promotion manager and assistant sales manager since joining the firm in 1951. He was formerly advertising manager, Eastern Electric Supply Co.

COMBUSTION ENGINEERING, INC., has elected **Lambert J. Gross** vice president and treasurer. Gross succeeds **Otto W. Strauss** who will continue as a vice president of the company until his retirement in October. Gross was formerly vice president, finance and treasury, and a member of the board of management of General Dynamics Corp. He joined General Dynamics as comptroller in 1947 and was named a vice president in 1951. He graduated from Princeton University and received an M.B.A. degree from New York University.

Gross

FISHER SCIENTIFIC CO. has acquired industrial Scientific, Inc., as a wholly-owned subsidiary. Industrial Scientific has branches in Fort Worth, Houston and Odessa, Texas, and a sales office in Baton Rouge, La.

UNITED STATES STEEL CORP.'s Products Division has named **Carroll R. Justice** vice president, sales. Justice joined U. S. Steel in 1936 at the Products Division's Los Angeles plant.

PARKER-HANNIFIN CORP.'s Fittings & Hose Division has appointed **A. N. Aiman** sales manager. Aiman has been with Parker Seal Co. for seven years covering the Cincinnati sales territory. Previously, he was a sales representative for Precison Rubber Products Co. and from 1947 to 1953 was with Hanover Electric Corp.

THE HAINGE CO., INC., Southwestern representative for F. J. Stokes Corp. has named **Frank Maher** director of sales of Stoke's vacuum systems and equipment. Before joining Hainge, Maher was North Central district manager for NRC equipment Co.

BECKMAN INSTRUMENTS, INC.'s, Scientific and Process Instruments Division has appointed **Paul E. Paules** Western Regional manager. Paules will manage sales and service for Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, Western Canada, Alaska and Hawaii.

WYANDOTTE CHEMICALS CORP. has named **Lewis C. Reid** export executive. He will serve as general manager, Wyandotte Chemicals International Division and assistant to the general manager, Michi-

gan Alkali Division. Reid worked for Davison Chemical Division, W. R. Grace & Co., before joining Wyandotte.

THE VAPOR RECOVERY SYSTEMS CO., Compton, Calif., has elected **Ray V. Long** president and general manager. Long assumed the vacancy created by the death of his father, **Frank V. Long, Sr.,** in June. He has served as executive vice president of the company since January. **H. Dickinson,** formerly vice president, engineering, was named to the board of directors as corporation vice president.

Long

NATIONAL CAN CORP. has appointed **Allen B. Falkman** canning technologist, Central Division, Research and Development Department. He was formerly food and coatings technologist with another major can manufacturer.

ANCHOR VALVE CO., San Francisco, has named John O'Rourke Advertising, Inc., to handle advertising and public relations. **Mel Dean** will serve as account executive.

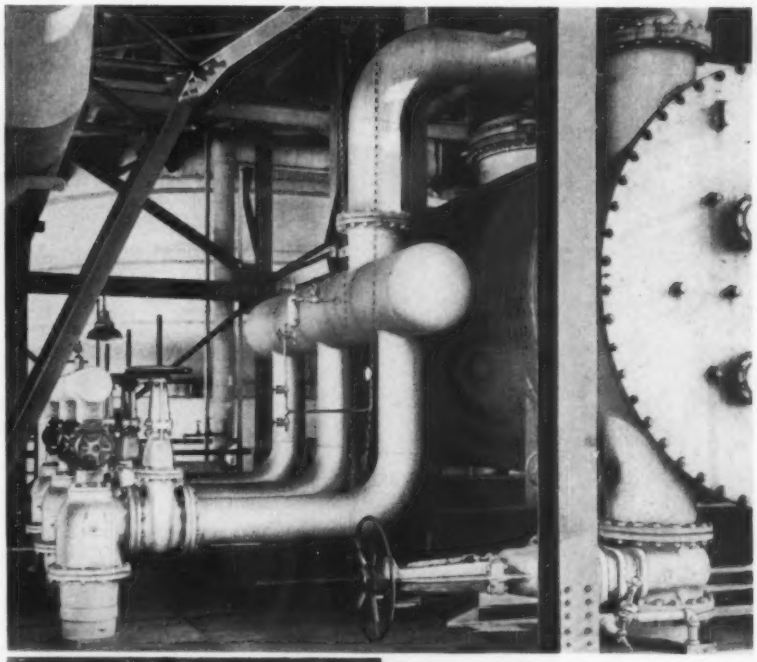
THOMSON ELECTRIC WELDER CO. has appointed **C. Dana Moore, John C. Grant, Jr.,** and **George R. Grant** to executive sales positions. Moore advances to sales manager, John C. Grant, Jr., moves up to become assistant sales manager, and George R. Grant becomes factory sales engineer.

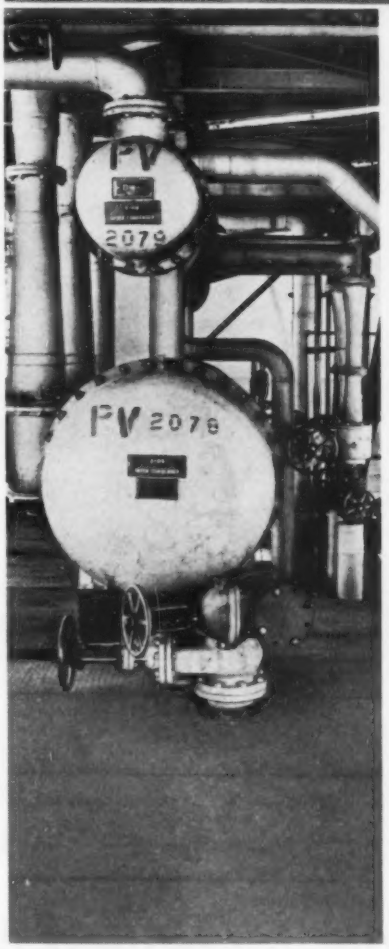
YUBA CONSOLIDATED INDUSTRIES, INC., has acquired Coynco Products, Inc., Tulsa, Okla. Coynco Products' Tulsa plant will be expanded and developed into a manufacturing center for Yuba's shell and tube and air-cooled heat exchangers. The operation will be known as the Yuba-Tulsa Corp.

DASHEW BUSINESS MACHINES, INC., has elected **Richard S. Brill** to the board of of directors. Brill is vice president, Hunter Engineering Co. Before joining Hunter Engineering, he was vice president, Bridgeport Brass Co.

THE BABCOCK & WILCOX CO.'s Refractories Division has named **R. P. Stuntz** manager field sales and **L. D. Christie, Jr.,** product manager, technical sales. Stuntz was formerly assistant sales manager. Christie was previously assistant to the division's technical director.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has appointed **Dr. Van W. Bearinger** director of research. **Dr. John N. Dempsey**





ELLIOTT VACUUM EQUIPMENT

maintains pressure of 75 to 100 mm Hg absolute in crude oil distillation unit

TWO-STAGE EJECTORS, with an Elliott 20,000-sq. ft. precondenser, a 3000-sq. ft. intercondenser, and a 900-sq. ft. aftercondenser were designed by Elliott Company to serve a new distillation unit. Suction chambers and diffuser inlets of the three 12-inch first-stage ejectors are shown at lower left in photo above.

BELOW THE FLOOR, left, are the vertical diffusers of the three 12-in. first-stage Elliott ejectors which exhaust into the 3000-sq. ft. Elliott intercondenser. Two 6-in. second stage ejectors, seen at the right, discharge into the aftercondenser.

ELLIOTT Company
Jeannette, Pa.

GO-2

For more data on advertised products, use Readers' Service Cards, last page.

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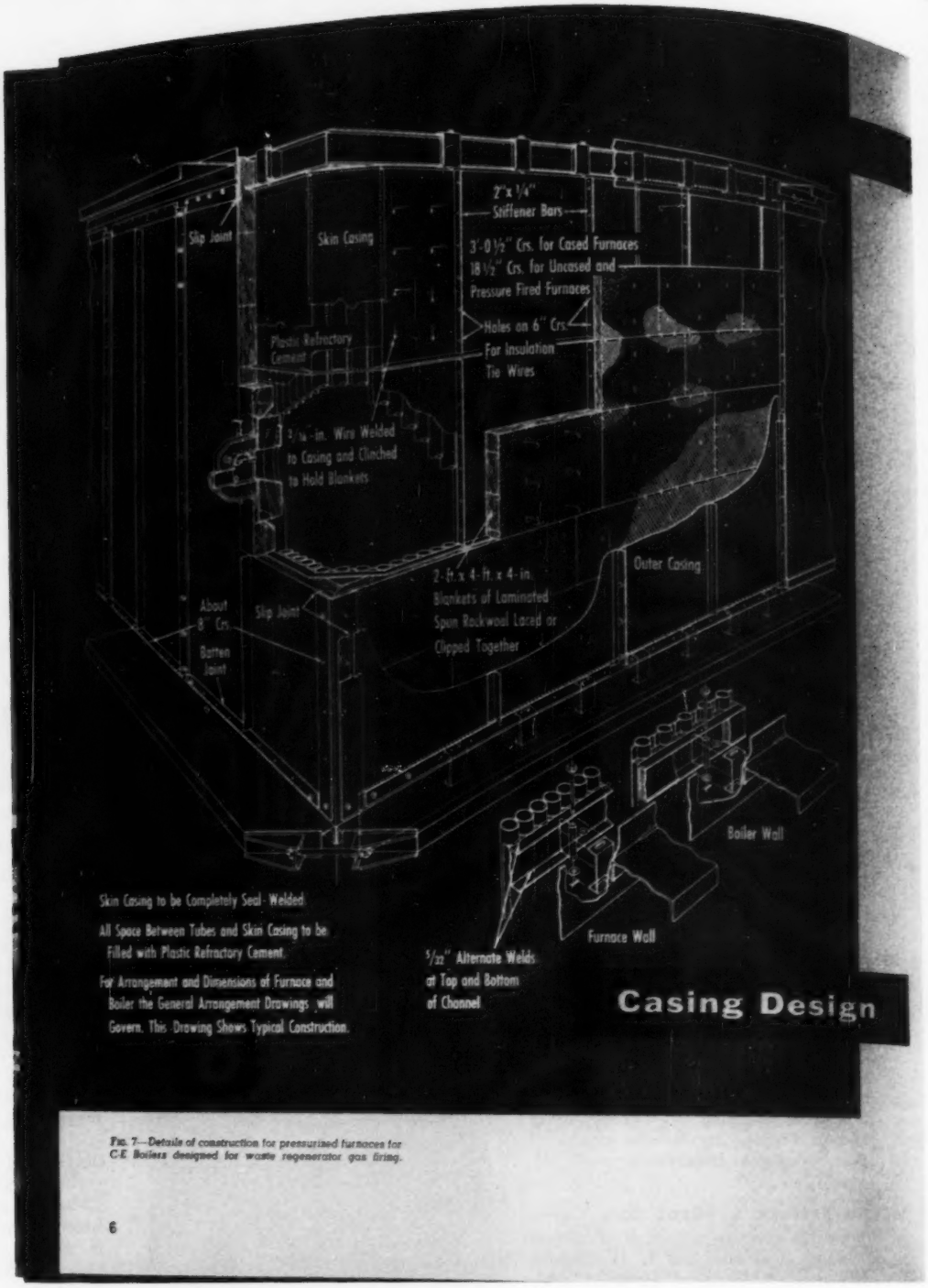
2"x 1/4" Stiffener Bars
Skin Casing
Slip Joint
3'-0 1/2" Crs. for Cased Furnaces
18 1/2" Crs. for Uncased and Pressure Fired Furnaces
Holes on 6" Crs. For Insulation Tie Wires
Plastic Refractory Cement
3/16-in. Wire Welded to Casing and Clinched to Hold Blankets
2-ft. x 4-ft. x 4-in. Blankets of Laminated Spun Rockwool Laced or Clipped Together
Outer Casing
About 8" Crs.
Slip Joint
Batten Joint
Boiler Wall
Furnace Wall
5/32" Alternate Welds at Top and Bottom of Channel
Skin Casing to be Completely Seal-Welded.
All Space Between Tubes and Skin Casing to be Filled with Plastic Refractory Cement.
For Arrangement and Dimensions of Furnace and Boiler the General Arrangement Drawings will Govern. This Drawing Shows Typical Construction.
Casing Design

Fig. 7—Details of construction for pressurized furnaces for C-E Boilers designed for waste regenerator gas firing.

6

For the whole fact-filled catalog, write . . .

20-PAGE C-E CO BOILER CATALOG

C-E Design for CO Boilers

Combustion Engineering CO Boilers are of advanced design, yet conventional in appearance, and use the time-tested C-E Tangential Burner in the four corners of the furnace. They require no specialized or complicated means to burn the lean, moist, toxic gas from a catalyst regenerator. Utilization of furnace volume is so efficient that combustion rates of over 40,000 Btu per cu ft and higher are practical.

These boilers are designed for pressurized furnace operation. The absence of induced draft fans assures minimum air pressure loss and fan horsepower requirements.

The double-cased furnace wall construction with inner (skin) casing welded to tangent wall tubes is designed for cubical expansion of pressure parts. With the skin casing in intimate contact with the tubes, its temperature at any point is the same as the tube temperature. Thus, though the entire furnace expands cubically, there is no relative expansion between the tubes and the skin casing. For this reason the skin casing can be completely welded. This construction is carried over to the [illegible] economizer side walls where the tubes are finned. The conventional rectangular furnace allows the preferred arrangement of boiler and superheater with uniform heating surface and gas-passage area per foot of furnace width. It also provides relatively quiet burner positions, assuring positive, stable ignition. Further, the rectangular shape permits an efficient system of platforms and stairways for observation and access. Heating surfaces are disposed to recover the maximum amount of heat with a minimum of baffling. The gas velocities through the boiler are high enough to prevent excessive settling out of catalyst, yet sufficiently low to avoid excessive erosion.

At a specified steam output, the circulation conditions in a CO boiler, when firing regenerator waste gas and auxiliary fuel, are entirely different than when firing auxiliary fuel alone. For this reason, the circulating system of C-E Boilers using these fuels is designed to handle the flows of water and steam for both these extreme conditions. Furthermore, the drum internals are designed to maintain the specified purity regardless of the fuel fired.

Either a C-E continuous finned tube economizer or a vertical tube, drum-type economizer is located after the boiler section. The finned economizer is normally selected when substantial quantities of supplementary fuel will be fired and higher efficiency can be justified. The vertical tube, drum-type is a more compact design suitable for minimum load CO boilers.

A notable feature of the C-E design is the unique arrangement of integral by-pass and [illegible] seal tanks in the lower portion of the stack. These tanks provide for safe, quick changeover from the stack by-pass to the burner supply duct. No by-pass stack with additional connecting ducts and breeching is required for handling the flow of the waste gas.

C-E Boilers for firing waste gas from catalytic regenerators are completely coordinated units combining boiler, furnace setting, fuel burning and forced draft equipment. This provides the extra advantage of having one contract, one guarantee and one responsibility. They are not necessarily the lowest in first cost, but the economies accruing from superior design, construction, reliability and overall operating cost will quickly offset any price difference between the least expensive boiler and the Combustion Engineering CO Boiler.

The fact that C-E Boilers have been selected to meet the exacting performance standards of so many of the nation's largest electric utility power stations is evidence of the design and construction you can expect to find in any boiler, large or small, that bears the Combustion name plate.

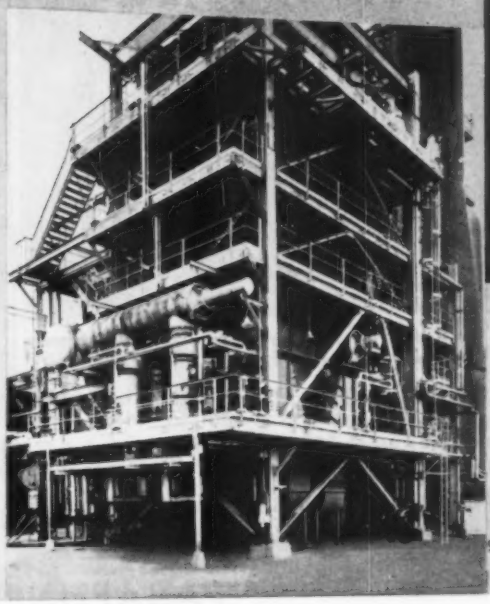

Fig. 8—C-E Boiler for waste regenerator gas firing in an oil refinery on the West Coast. The sectional side arrangement of this boiler appears on page 8.

C-290

COMBUSTION ENGINEERING

210 Madison Avenue, New York 16, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

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DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

Suppliers . . .

and **Edward E. Rexer** were named assistant directors. Bearinger has been associate research director since 1956. He fills a vacancy created about a year ago when **Dr. Finn J. Larsen** was elected a corporate vice president in charge of research.

GROVE VALVE AND REGULATOR CO. has named **Ernest H. Rettig** as its first full-time sales and service representative for South America. Rettig was formerly with El Paso Natural Gas Co., where he served as a technical representative in the project engineering and pipeline construction departments. A graduate of Texas Western College with a degree in Inter-American affairs, Rettig will be selling Grove's complete line of valves. He will be headquartered in Houston, but will make frequent sales trips to South American countries.

Rettig

ELION INSTRUMENTS, INC., plans to establish an International Division. The division will be primarily interested in sales for Western Europe. **E. J. Guilfoy,** vice president of sales for Elion, will direct the sales for the new division.

BECKMAN INSTRUMENTS, INC.'s, Scientific and Process Instruments Division has appointed **Robert L. Solnick** chief project engineer, sample handling systems. Solnick had been with the Fluor Corp. eight years before joining Beckman.

NORTON CO. has appointed **Richard S. Johnson** supervisor of industrial hygiene and safety. Johnson joined Norton in 1957 as an industrial hygienist. He graduated from Clark University.

SYNFLEX PRODUCTS DIVISION, Samuel Moore & Co., has appointed Hope Rubber Co., Fitchburg, Mass.; F. B. Wright Co., Dearborn, Mich.; Shively Bros., Inc., Flint, Mich.; and Kent Rubber Supply Co., Grand Rapids, Mich., distributors.

NATIONAL CAN CORP. has named **I. Martin Long** manager, Baltimore, Md., plant. Long was formerly staff assistant to the division manager of manufacturing. He joined the firm in 1959.

UNION CARBIDE DEVELOPMENT CO. has appointed Leonard F. Luchner Co., Inc., sales representative for ULOK cube air filters in Rhode Island, New Hampshire, Maine and in some counties of Massachusetts.

HOOKER CHEMICAL CORP. has named **Horace W. Hooker** manager of licensing. Hooker, formerly sales manager of the firm's Western Chemical Division, joined Hooker Chemical in 1934. He will continue as a vice president and a director of Hooker Chemicals, Ltd., a Canadian manufacturing subsidiary.

THE BABCOCK & WILCOX CO.'s Tubular Products Division has appointed **John A. Menster** manager of welded tubing sales. Menster joined Babcock & Wilcox in 1943 as a sales correspondent at the Alliance, Ohio, plant. Later he served as manager of the Alliance sales office. He has been assistant manager in charge of welded tubing sales since 1950. He graduated from Ohio University.

Menster

NORTON CO. has named **Robert H. Gow** supervisor of industrial engineering in the crushing plants. **Ercell R. Stevens** has been appointed abrasive grain engineer in the company's West Coast district. Gow joined Norton in 1955, and Stevens came to the company in 1948.

THE BRISTOL CO.'s New Jersey branch office has moved from Newark to 420 Morris Ave., Springfield, N. J. **J. F. Peterson** is the branch manager.

DIAMOND ALKALI CO. has elected **J. A. Hughes** and **W. H. McConnell** senior vice presidents. Hughes was vice president, administration and secretary, and McConnell was vice president, marketing.

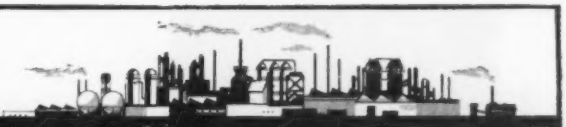
CLEAVER-BROOKS CO. has named **H. F. Holtz** vice president and general manager, Packaged Boiler Firetube Division. **James G. Brooks** and **J. E. Uihlein, Jr.**, have been appointed directors.

CELANESE CHEMICAL CO. has appointed **Robert L. Mitchell** vice president, planning. Mitchell joined Celanese in 1947 and had been serving as director of technical and economic evaluation.

ATLAS POWDER CO. has elected **Thornton F. Bradshaw** to the board of directors. Bradshaw is a vice president and member of the board of directors, The Atlantic Refining Co.

PARKER SEAL CO. has appointed **William A. Taylor** sales representative for Pittsburgh, Pa., and surrounding area. Taylor was formerly with W. W. Baerblack & Associates, Dayton, Ohio.

HEYDEN NEWPORT CHEMICAL CORP. has named **C. H. Shields, Jr.**, manager, Market Research and Development Department. Shields has been in market development for the company's organic chemicals since 1957. He was previously with General Electric Co. as a product engineer.



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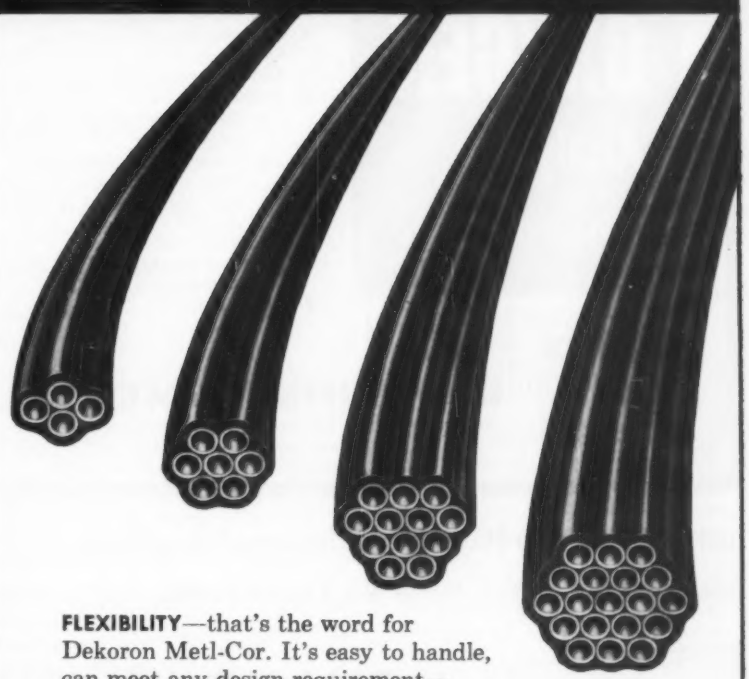
cuts installation costs
bends without distortion
solves instrument line corrosion problems



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FIRST, Metl-Cor's exclusive Extru-Loc construction makes it easy to bend with no tube distortion.

SECOND, the Metl-Cor design is flexible. You can specify Metl-Cor with core tubes in either copper or aluminum . . . in any standard or special OD or wall thickness . . . with almost any number of tubes in each bundle.

MOST IMPORTANT, no matter which type or size you specify—you get all the inherent cost-cutting savings and longer life that you pay for.

AA-7611

Dekoron Tubing is available in many other forms: Dekoron Poly-Cor; M-Ribbon; P-Ribbon; Protecto-Pac; Armored Poly-Cor and Metl-Cor; and single-line Dekoron Tubing.

Dekoron® products
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MODEL 11-4500

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2. Simple non-electronic circuit.
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   a) Standard or explosion-proof construction.
   b) Five-inch scale indicating meter. Alarm contact and relay optional, also conventional electronic recorder controllers.
   c) Floor standing cubicle or panel-mounted cabinets.
7. Ranges from 0 — 5% O_2 to 0 — 100% O_2.

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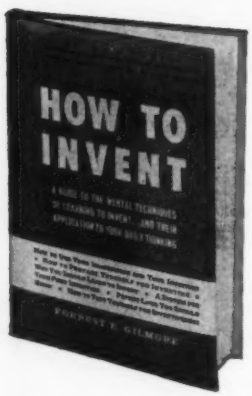
Just Because You Have Never Invented Anything Does Not Mean You Have No Talent For It.



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Graduate Chemical Engineer having a minimum of 3 years experience in technical service for refining and petrochemical plant operations involving process design, studies of optimum yield and quality control, performance tests, economic analysis and project evaluations. Excellent benefits and promotional opportunities. Send complete resume of personal, educational and business background. Replies will be held in strict confidence.

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Planning and economics section. Graduate Chemical Engineer with 5-10 years refining experience for refinery organization, cost analysis and control, budget coordination, new project evaluation and long range planning for fuels, products and petrochemicals. Excellent benefits and promotional opportunities. Submit complete resume covering personal, educational and business background. Replies will be held in strict confidence.

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Excellet benefits and promotional opportunities. Send complete resume of personal, educational and business background. Replies will be held in strict confidence.

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West Coast manufacturer of process analyzers for use in petroleum refining and petro-chemical plants has an opening in Houston area for a Sales Engineer. Sales ability with refining experience, preferably as a Process Engineer, is required. In addition to selling, responsibilities include recommending specific applications, assisting in installations start up and calibration of analyzers. This position will demand considerable travel. Excellent opportunity for growth with a well established, expanding company. All answers will be considered strictly confidential. Send resume to General Sales Manager, Technical Oil Tool Corporation, 1057 N. La Brea Avenue, Los Angeles 48.

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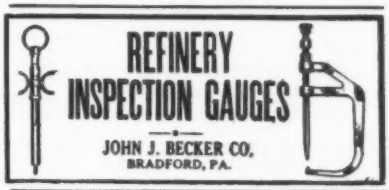

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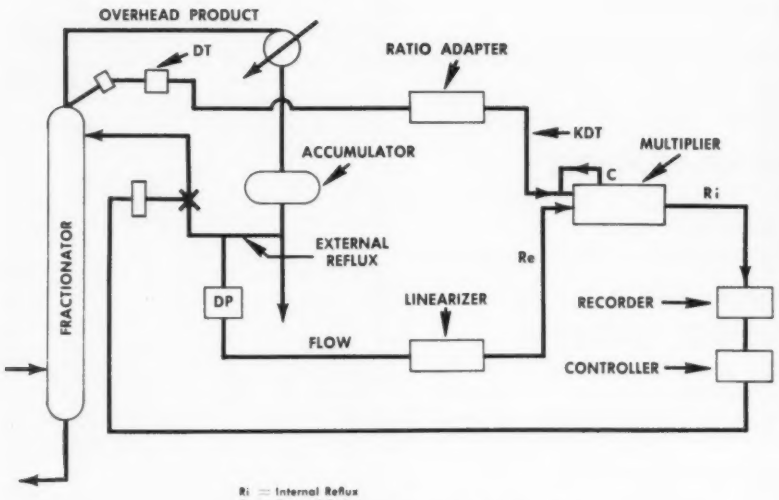


Ri = Internal Reflux
Re = External Reflux
DT = Temperature difference between Re and overhead vapor
$K = \frac{\text{Specific heat of Re}}{\text{Heat of vaporization of Ri}}$
C = Constant value

$$Ri = Re\ (C + KDT)$$

Controller Stabilizes Fractionator Tower

A new fractionator control system prevents column upsets caused by ambient-temperature changes on external reflux. Named the Internal Reflux computer, it uses a new control method, originally developed and licensed by Phillips Petroleum Co., in which standard electronic instrument components are employed to compute internal-reflux flow and keep it constant.

The new controller computes internal-reflux flow from measurements of the external-reflux flow rate and the difference in temperature between overhead product and the external reflux. It maintains a constant internal-reflux flow by regulating a valve on the external-reflux stream.

The primary advantage of the new control method is that it is much faster than the traditional method of regulating the temperature of the external reflux. The Internal Reflux Computer corrects the external-reflux flow rate quickly enough to prevent changes in the temperature differential—between overhead product and external reflux—from causing upsets in the fractionating tower operation.

Additional operating advantages are realized from the use of the new control system. Tighter control permits the fractionator to operate closer to the flooding point, thereby increasing its capacity. Also, less reboiling steam is required because large surges of internal reflux that normally lower the temperature are eliminated. Equally important is the fact that closer fractionator control increases the uniformity of the products.

Since the new fractionator controller is composed of standard instruments, it easily can be installed and maintained by plant instrument engineers. Swartwout Div., Crane Co.

Circle E1 green card, last page

Hot Lines Can Be Checked With Ultrasonic Tester

Thousands of feet of tubing can be tested daily by a triple-eye ultragauge inspection team, spotting pipe with erosion or corrosion pitting even on hot lines, on stream. Here an inspector scans a section of typical refinery tubing with the Ultracoupler sensing unit, while an engineer reads an accurate (up to five thousandths of an inch) interpretation of thickness and flaws in the tube on the monitor. The

heart of the system is a focused ultrasonic transducer, the Ultracoupler, which allows a hairline width of ultrasound to be focused on tubular goods and other metallic material. Because ultrasound will not travel through air, water is used as a medium between the crystal transducer and the equipment being inspected. International Inspection, Inc.

Circle E2 green card, last page

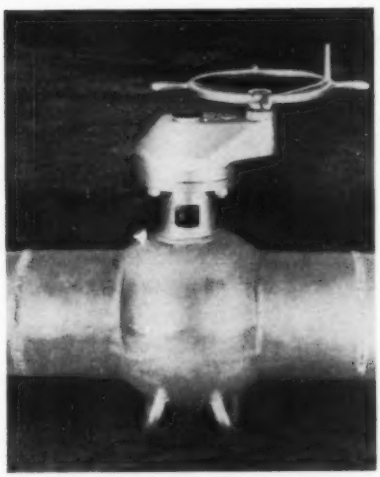
Low-Cost Ball Valve Made In Large Sizes

Using the principle of rotating seats, already proved successful in gate valves, opens the way for other money-saving advances in a new and unique ball valve.

The low-cost valve has no bonnets, no gaskets, and no joints. Moreover, the new ball design requires no lubrication to seal bubble-tight, is compact in size, and weights only a fraction as much as others designed in its class.

Because of these advances and the long life of the rotating seats, the valve performs at a saving even in highly abrasive and corrosive fluids. Because of the compactness and lightweight, even large sizes (up to 36 inches) are easier to install whether in a ditch or overhead. Shipping and storing the valve are cheaper; and it may be insulated quickly and inexpensively.

It may be installed in the most convenient position, without regard to top or bottom. And, all types of electric,

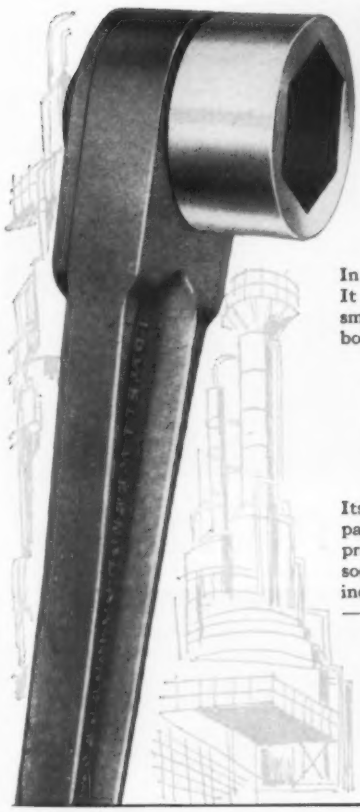


pneumatic, and hydraulic operators already on the market may be used with it.

As another advantage, the two-seat construction seals both upstream and down. Thus, the line may be backed in both directions and the body of the valve bled off. Moreover, each time the valve is operated, the spaces between seats and in the body cavity are flushed out. This self-flushing eliminates sticking and prevents any possible damage that might result from freezing.

The valve body is forged in two halves. After these halves have been semi-finished, internal parts are set in place and the two body forgings are welded together. The resulting body is rigid and has a uniform cross section so that it is unaffected by line strain.

The ball plug is forged, machined and then polished so that its surface is true and smooth. The valve operates with a fraction of the effort required by other



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In any refinery, this wrench is a sure time saver. It works fast. That's the real advantage of its smooth operating ratchet . . . a man can do any bolting job just as fast as he can turn the handle:

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Its exclusive hole-thru feature allows the bolt to pass through the head — so bolt length is no problem. And each handle takes a variety of socket sizes. *Standard sizes: Handles* — 8 inches to 6 feet long; *Square or Hex Sockets* — up to 9⅛ inches.

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115 Temple St., Worcester, Massachusetts

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CHECK PUBLISHED MISALIGNMENT RATINGS BEFORE YOU BUY

Since misalignment is the basic problem that shaft couplings are designed to solve you'll find a published conservative misalignment rating (along with load capacity rating) for every Fast's Coupling. Compare it with the misalignment rating of any other coupling you are considering.

One further advantage of Fast's Couplings' misalignment ratings: You save money on installation because, knowing the ratings, you don't have to line up driving and driven elements with pinpoint accuracy. It's one more important reason why Fast's Couplings are the choice of more equipment manufacturers than any other gear-type coupling. KOPPERS COMPANY, INC., 1509 Scott Street, Baltimore 3, Md.

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- ► REMOVABLE PLUG WITHOUT REPLACEMENT OF BELLOWS

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Equipment . . .

designs. Much larger sizes than usual can be operated by hand using only a simple lever. Only one quarter turn is needed to fully open or close the valve.

The valve is made in sizes from 2 inches to 36 inches for 150 through 600-pound ASA classes and in 2 inches through 6 inches for API 1,000 psi to 5,000 psi working pressure rating. Cameron Iron Works, Inc.

Circle E3 green card, last page

Anti-Slip Surfaces Assure Safe Footing At AMOCO

A major hazard to foot traffic has been virtually eliminated in the pipe-still pump house of American Oil Co's refinery at Wagner's Point in Baltimore, Md.

By applying an anti-slip surface coating to a 1½-foot-wide steel gutter floor plate, personnel are assured of safer footing alongside pumping machinery. Called

"Dura-Grip," the surfacing compound is a bonding resin impregnated with grit.

According to John Lavin, American Oil Safety engineer, "Personnel were subject to excessive slipping before the coating was applied last February. Located in the heart of the refinery, the plate is constantly exposed to water and oily substances. On bare metal, these elements are extremely dangerous.

"However, tiny grit particles in the

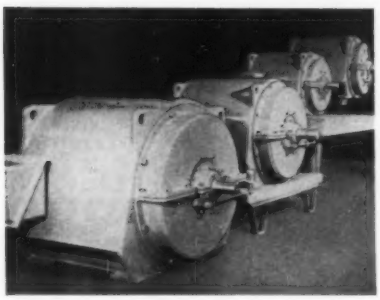
Dura-Grip surface coating protrude above the resin to form a grainy surface that is literally slip-proof. This helps the men anchor their feet on the plate when operating overhead valves off the main steam line, and gives them safe footing for other service duties."

Applied like paint, the first coating was sprinkled with grit while still wet. After an hour's drying time, excess grit was swept off and recovered. A second coat was then applied to secure the grit in place and seal the surface. After six hours' curing time, the plate was ready for light traffic, and after 16 hours it was safe for heavy foot traffic. Mine Safety Appliances Co.

Circle E4 green card, last page

Squirrel-Cage Motors Show Compact Enclosures

A new line of large squirrel-cage motors, 250 through 1,000 hp have been built for heavy duty industrial applications. These motors feature extremely compact, smoothly contoured, fabricated steel plate enclosures that have great mechanical strength and high resistance to corrosion. For safety and ease of handling, four lifting eyes are built in as



integral parts of the frame ends. Mounting space required is materially reduced by positioning the feet under the overhang of the frame.

The flat steel end plates are built in two sections, facilitating disassembly for bearing inspection, if required.

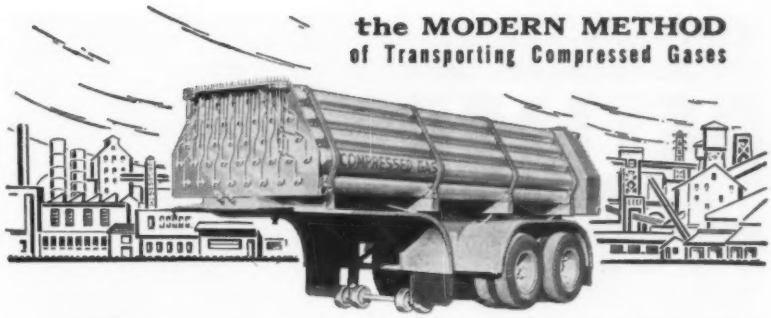
The enclosure is completely drip-proof with ventilating openings so located and shielded as to provide essentially splash-proof protection.

Available voltages are 440, 550, 2,300 and 4,160 volts, 60 cycles. The entire range of ratings, 250 through 1,000 hp, can be supplied with full load speed of 3,500, 1,750 or 1,160 rpm; 870 and 690 rpm motors are available through 700 hp, and 575 rpm motors through 500 hp.

Sleeve bearing models can be furnished in the entire range of ratings and speeds; ball bearing models through 400 hp, all speeds, and through 900 hp at some of the lower speeds. Wagner Electric Corp.

Circle E5 green card, last page

the MODERN METHOD of Transporting Compressed Gases



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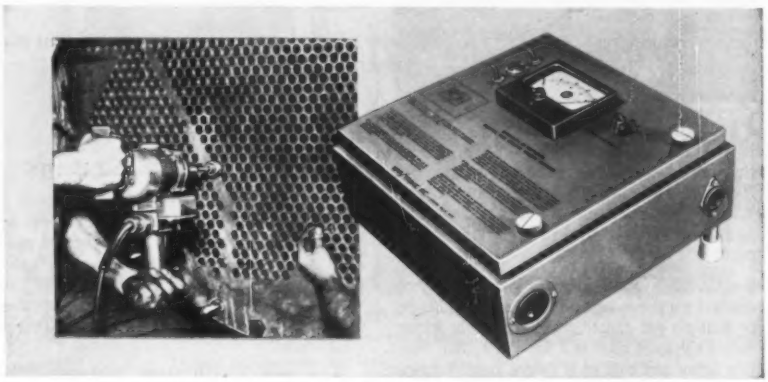

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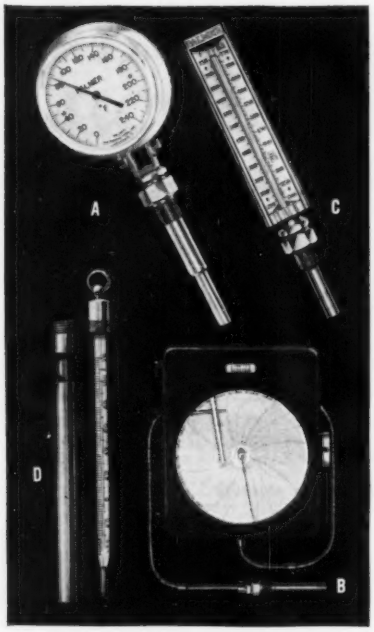

A—4½" DIAL THERMOMETERS: Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

B—RECORDING THERMOMETERS: Twelve inch die-cast aluminum case with black finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: —40 +950° F or Equivalent in °C.

C—INDUSTRIAL THERMOMETERS: Red-Reading Mercury—Extruded brass case—chrome finish. Ranges: —40 +950° or Equivalent in °C.

D—RED-READING MERCURY LABORATORY THERMOMETERS: Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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Equipment . . .

Gate, Globe, Check Valves Feature Hard-Faced Seats

A new line of gate, globe and check valves with 150, 300 and 600 psi, ASA flanges feature hard-faced seats and hardened wedges and discs, spiral-wound body-bonnet gaskets, stainless steel glands studs and nuts, and interchangeable parts. The valves are available in sizes from ½ to 2 inches. Henry Vogt Machine Co.

Circle E6 green card, last page

Structural Steel Gives 6 Percent Weight Savings

Average savings of 4 to 6 percent in the weight of steel structures are promised by a new and higher-yield point structural carbon steel. The new steel conforms to specification A36-60T for rolled structural steel recently approved by the American Society for Testing Materials.

The new specification is a significant step in terms of potential savings for the heavy construction field. Because A36 has a higher minimum yield point than present standard carbon structural steels, it should gain rapid acceptance and ultimately become of dominant steel used in structural applications.

The new A36 structural steel has a minimum yield point of 36,000 psi. Matched against A7 steel on an equal weight basis, A36 will withstand about 10 percent greater load in tension before it reaches its yield point. On the same equal-weight basis, A36 steel has about 12 percent yield point advantage over weldable A373 grade. Moreover, A36 compares favorably with A373 from a weldability standpoint.

The prices for A36 steel are 5 cents per pound higher than A7 for all structural shapes and for plates up to ¾-inch in thickness which represent the bulk of

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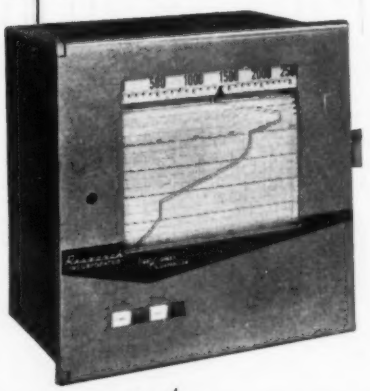

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brings new flexibility to the automation of industrial process with closed-loop control.

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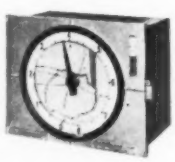
2. **Superimposed Recording** — PreKorder's permanent record of process performance on a program chart overlay permits continuous visual comparison of record and chart.
3. **Programmed Limits**—To trigger alarm or shut-down circuits in case of process malfunction, just pencil allowable operating limits on the recording chart.
4. **Programmed Gain** — Varying the space between pencilled program lines varies the proportional control band or system gain.

Typical PreKorder applications are in programming temperature, pressure, power, load, flow, position, and other process variables. Both round and strip-chart models are available.



RI RESEARCH INCORPORATED

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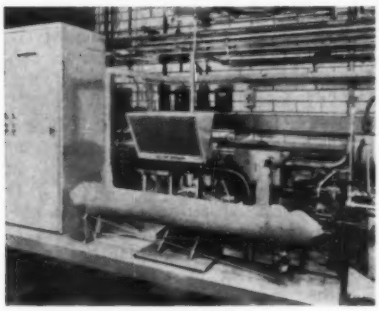
steel used in construction. The A36 price difference over A7 is greater for plates and bars over ¾-inch because of additional chemical requirements necessary to produce these thicknesses. For bars up to ¾-inch in thickness, the price is the same as A7. All in all, the "cost to strength ratio" of the new steel is substantially better than for existing carbon structural steel specifications and cost savings should result for most fabricated and erected structures. United States Steel Corp.

Circle E7 green card, last page

X-ray Analyzer Controls Process Fluid Quality

Continuous on-line analysis of several chemical elements is for the first time possible with the new X-ray emission gage (XEG). The gage consists of an electronic control cabinet that houses all power and measuring components and a measuring head that houses an X-ray tube and other analysis components. The



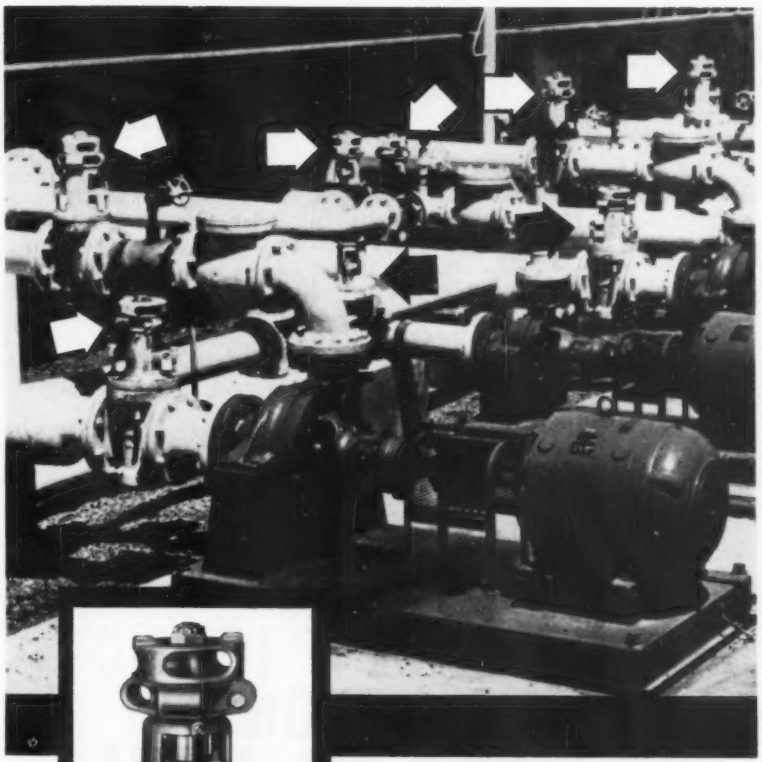
fluid material being analyzed, is flowing through a pipe under the measuring head. The pipe has a specially constructed, X-ray transparent window (not shown).

Output from the gage is used for computing, control, and indication, and can be calibrated to show any desired measurement: percent, pounds per ton, tons per hour, etc. It also can control the degree and quality of finished mixes and blends. It can check the efficiency of a process and thus refine it by analyzing elements in the end product. General Electric Co.

Circle E8 green card, last page

Booklet Tells How to Talk Computer Language

Are you man or mouse when conversations turn to computers? Do you suspect that such simple English words as address, drum, gate, bit and patch mean



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more than they used to mean?

If so, you'd beter brush up on your "computerese."

Because of the baffling technical jargon surrounding "electronic brains," a pocket-size 22-page glossary intended to make computer language more intelligible has been published.

The booklet defines some 82 terms which the instrument producer's own engineers have helped to create in building industrial process computers.

The booklet then explains how a process control computer functions, but you'll need the dictionary to understand it. Mnemonic code, for instance, is a list of computer instructions written in a form which can be remembered easily by the persons who program them.

A binary coded decimal, the glossary explains, is a system of representing decimal numbers, while a binary scale is a numbering system whose simplicity makes it ideal for computers, which, let's face it, "are highly illiterate devices." Radix is simply the numbering system's base.

As for a bit, it isn't a small portion or part of a bridle that's inserted in a horse's mouth. It's short for binary digit, of which there are two—0 and 1—used in converting a decimal number into a binary number. Minneapolis-Honeywell Regulator Co.

Circle E9 green card, last page

Tank Car Loading Safer With Retractable Gangway

With the versatile "Hemco Gangway," operators can walk from elevated loading racks to the top of any size or type of tank car or tank truck quickly, easily, and with complete safety. It is adjustable vertically, giving a level walk out to the top of any size car, and it is adjustable in length with a retractable extension, giving a full walkway all the way out

to any type car. In addition, it swivels, providing easy and safe access to cars that are spotted incorrectly. After use, it folds back to provide necessary clearance.

The unit comes as a package, completely assembled, ready to install on existing or new racks by clipping it to the walkway. All operations are performed automatically by hydraulic components, powered by plant air where it is available, or by a hydraulic pump furnished by the manufacturer. Houston Engineering & Mfg. Co.

Circle E10 green card, last page

Variable Flow Pumps Make Low-Cost, Accurate Blends

A new kind of pump is being used to build simplified, low-cost systems for proportioning liquids.

Two or more of the Vari-Flo units (depending on the number of base stocks to be blended) are coupled directly together so that all must turn at the same speed. If the dial settings on each are different, then the flow from each will be proportionately different, even though the units are turning at identical speeds. If one of the units hesitates or stops, all will do the same, and the proper ratio will remain unchanged.

One of the most common applications is the blending of asphalts, where diluents are combined with a penetration grade to provide any desired cutback. Another is the blending of various grades of gasoline to obtain intermediate octane ratings,

A NEW EXCLUSIVE INSULATING PRODUCT DARLINGTON 85% SUPER–MAGNESIA

Darlington precision-moulded 85% Super-magnesia is a new and improved form of 85% Magnesia insulation possessing many superior physical characteristics.

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WATER-RESISTANT. Even boiling in water for twenty-four hours has no effect on the shape and form of Super-magnesia! It is a material of particular value for external or humid conditions.

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PRECISION-MOULDED. Super-magnesia is cast to precise dimensions and shapes to ensure a snug and exact fit.

CLEAN AND EASY TO HANDLE. Super-magnesia has a smooth white finish free from 'fluffiness'. It may be sawn and cut to shape easily, and without mess.

REMEMBER—Darlington 'Supermag' costs no more than ordinary 85% Magnesia!

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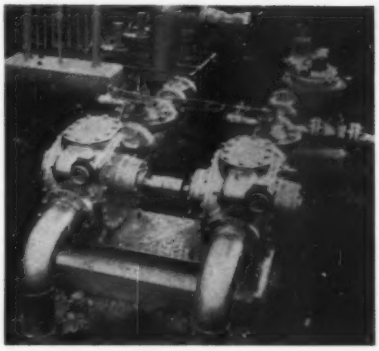


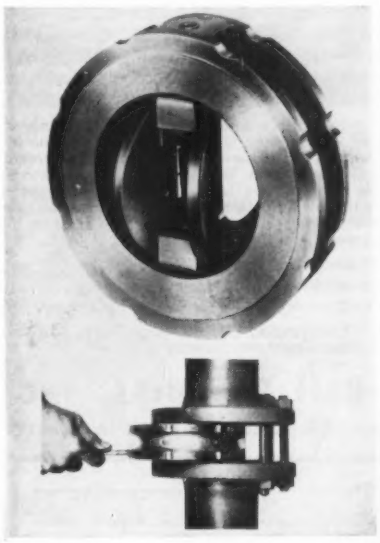
(see photo). Here the proportioner is being used to blend a low octane with a high octane gasoline to obtain an intermediate grade. Supply tanks and pumps are located to the left just out of the picture. Discharge lines from the proportioner go underground and are joined together at a loading rack farther downstream. Blackmer Pump Co.

Circle E11 green card, last page

Check Valve Fits Between Flange Faces

The "Duo-Chek" valve fits between flanges and features new concepts in sealing to withstand all pressures. Of particular importance is the fact that the valve averages 90 percent smaller than any other check valves of similar pipe size.

A new type resilient seal withstands all pressures without leaking or damage. The sealing material is molded into a groove



in the plate, making an O-ring type seal. Pressure deforms the seal until metal-to-

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Maintenance Time: 40 Seconds. If it now takes your maintenance crew more than a couple of minutes to service an ordinary trap, you're throwing away valuable time. This Sarco Thermo-Dynamic can be cleaned, blown out if necessary, and reassembled on the line in as little as 40 seconds.

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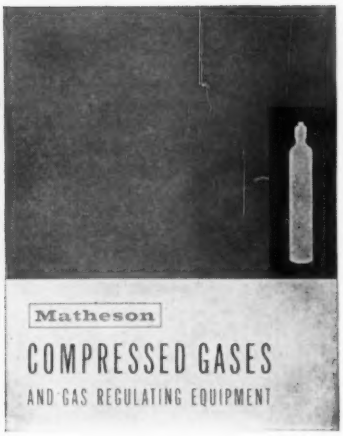

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Equipment . . .

metal contact is made by the plate with the body seat, which completely encloses the synthetic sealing material to prevent pinching off under pressure. A teflon seal and a metal seal also are available.

The valves feature an anti-slam spring closure that assures positive seating without slamming, yet opens with only ounces of pressure on the upstream side.

One valve fits both ASA 150 series and 300 series flanges in sizes 4 through 12 inches. In sizes 2 and 3 inches, one valve fits ASA series 150, 300 and 600 flanges. Mission Manufacturing Co.

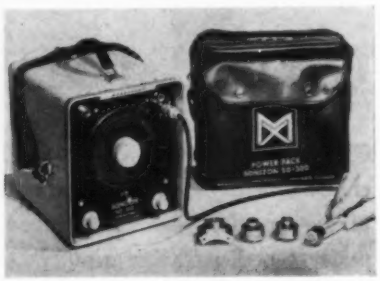
Circle E12 green card, last page

Ultrasonic Tester Is Fully Transistorized

A completely transistorized battery-operated ultrasonic instrument for measuring wall thickness between .025 inch and 2.50 inch, named Sonizon SO-300, gives instantaneous reading by simply placing a transducer on the surface to be measured and turning a dial.

The unit measures with an accuracy of 1 percent when calibration is checked during tests against known sample of the same material. Three knobs provide complete control of the entire test procedure.

To determine the thickness of a material, the operator selects the correct range and places the transducer on surface to



be measured. He then rotates the harmonic scale disc until division lines coincide most accurately with the light pattern caused by rotating neon bulb flashing in phase with scanned frequency. The thickness indicator then points to the direct thickness reading, in inches, on the outer scale.

Both quartz and the more sensitive lithium sulphate transducers can be used with the SO-300. A liquid couplant must be applied in order to transfer ultrasonic vibrations between the transducer and the test material. Magnaflux Corp.

Circle E13 green card, last page

Portable Bundle Cleaner Uses High Pressure Water

A new approach to hydraulic cleaning of heat exchanger tube bundles and other

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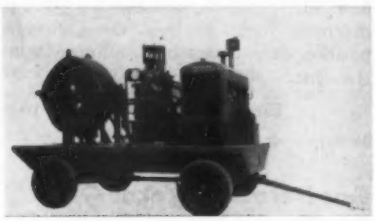
Equipment . . .

cleaning and descaling operations, the portable HYJET unit, uses a jet stream of water up to 4,000 psig or higher through a high-pressure nozzle. A wide range of pressures and capacities is offered to fit requirements. No cleaning solutions or solvents are necessary.

The jet is easily controlled and does not require a skilled operator. It is



equipped with a "dead man" safety control feature that automatically shuts the unit off when jet nozzle is unmanned.

The unit can also be used for decoking, slag cleaning, casting de-burring, paint and scale removal and hydrostatic testing. The units are powered by gasoline, electric or steam power, and are available in portable or skid mounted models. Power Specialty Co.

Circle E14 green card, last page

Liquid Level Control Whips Vibration Problem

Where vibration and corrosion are serious problems, a new model 752 single-stage, external-float-cage liquid level control provides an anti-vibratory, corrosion-resistant liquid level control as a high-level alarm on scrubber service with 0.6 specific gravity hydrocarbon liquid at 500 psi, with high ambient temperature conditions.

It can be equipped as either an electric or pneumatic control. A new electric switch mechanism provides a magnet-actuated, two-position, snap-action mercury switch of utmost reliability. Anti-vibration features include: (1) The angle of the magnet "swing" has been increased to provide a greater angle of tilt to the mercury switch, eliminating any splashing of mercury across contacts under most severe vibration conditions. (2) The mercury switch itself is anti-vibratory. Movement of mercury caused by vibration is immediately dampened by the surface tension of the mercury against a center electrode which is formed in a

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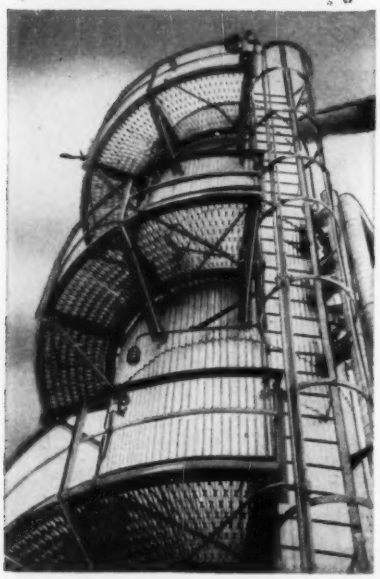

Walkways, catwalks and treads made of solid wood, metal or other material can collect snow, rainfall, grease or oil and become dangerously slippery.

But these walking surfaces, made of an open mesh of metal bars on edge, cannot collect these substances, leaving the surface always *clean*, dry and tractional for safer access to high places.

As founders of the grating industry, the Irving Company can draw upon over half a century of experience to supply you with quality grating products for catwalks, treads and other practical and economical uses.

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Equipment . . .

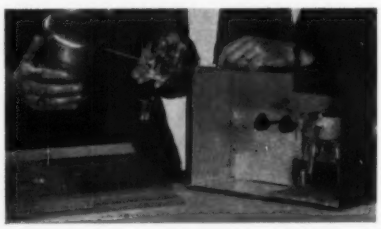
wavy shape, and which extends the full length of the glass tube.

For applications where pneumatic switch operation is perferred, the control is equipped with a new J-2 pneumatic, non-bleed switch. The pneumatic head is also a magnet-actuated, two-position, snap-acting switch—anti-vibratory because of its dual magnet design that provides positive snap-action for both "on" and "off" positions, and that also utilizes magnetic force to hold the air valve position despite severe vibration. Magnetrol, Inc.

Circle E15 green card, last page

Gas Detector Warns Of Pre-Explosive Mixture

A new gas detection instrument, the Air Density Monitor, is the first gas detector to use a mechanical balance principle. This enables the monitor to operate around the clock without an attendant, and without power. The Detectogas Monitor detects changes in air density caused by accumulation of gases and



vapors. When a density change of as little as 1.2 percent occurs, the monitor automatically activates any type of alarm system through its explosion-proof switches.

Changes in temperature, humidity and pressure do not affect the instrument because of an integral compensator system.

About the size of a breadbox, the monitor sells for less than one-third the cost of existing automatic gas detection equipment. Detectogas Instruments, Inc.

Circle E16 green card, last page

Welding Fittings Made In Pre-Shaped 45° Saddles

Pre-shaped saddle fittings are now available in 45° angles. Manufactured of high-strength seamless tubing in three weight schedules, the fittings come in A-53 for most piping requirements and A-106 grade B for higher pressure applications. Grade A-106 can be delivered with a mill test certificate if requested. Sizes range from 1 inch through 12

now available . . .

NEW EDITION of UOP LAB TEST METHODS BOOK

Recognized as a basic book on petroleum laboratory technique, "UOP Laboratory Test Methods for Petroleum and Its Products," is now available in a new fourth edition. A valuable supplement to standard ASTM, APHA and API test methods, this 618-page edition details 89 test procedures of great practical value to refinery laboratories.

The book includes spectrophotometric and gas-liquid chromatographic procedures; analytical methods for determination of trace metals, nitrogen and sulfur compounds in hydrocarbon streams; distillation methods and other useful tests. All test methods reflect the latest practices of UOP's research laboratories. Illustrations include the more complex apparatus, typical calibration and working curves, nomograms and graphs.

Copies of the new edition are available at $25 (U. S.) each, postpaid. Order directly from:

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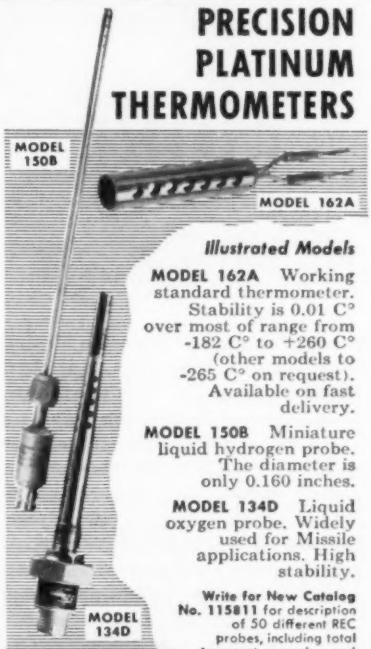
PRECISION PLATINUM THERMOMETERS



Illustrated Models

MODEL 162A Working standard thermometer. Stability is 0.01 C° over most of range from -182 C° to +260 C° (other models to -265 C° on request). Available on fast delivery.

MODEL 150B Miniature liquid hydrogen probe. The diameter is only 0.160 inches.

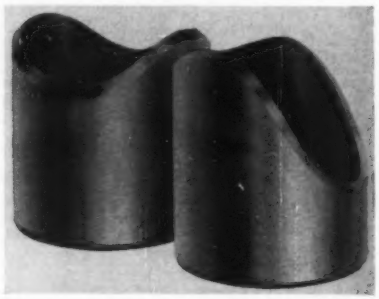
MODEL 134D Liquid oxygen probe. Widely used for Missile applications. High stability.

Write for New Catalog No. 115811 for description of 50 different REC probes, including total temperature probes and surface probes.

REC ROSEMOUNT ENGINEERING COMPANY
4902 West 78th St.
Minneapolis 24, Minn.

inches for welding and 1 inch through 4 inches for threaded filling. All are beveled for welding. Special fittings 1 inch through 36 inches in aluminum, alloy or stainless steel are available in any desired angle.

Installation of pre-shaped fittings is done in three steps—marking, cutting,



and welding. Users say they are leak-proof, strong, lightweight and easy to handle. It appears that pre-shaped fittings, used in conjunction with existing holecutting equipment, may offer a solution to the problem of reducing the high cost of pipe fabrication. Allied Piping Products Co., Inc.

Circle E17 green card, last page

Lube Oil Filler Handles 800 Quarts Per Minute

A new Votator rotary piston filler that can fill up to 800 quart containers of lubricating oil per minute possesses the largest capacity of any filler available for packaging of lubricating oils and related products, a spokesman said. It has 33 percent greater capacity than the P27L unit, previously largest in the Votator line, which has a rated capacity of 600 quart cans of SAE 50 lube oil per minute.

The unit was designed for increased productivity and lower operating costs per unit at only a small increase in initial investment. It is engineered for proper synchronization with associated equipment in continuous automatic packaging lines handling lubricating oils, upper cylinder and friction-proofing lubricants, brake fluids, antifreezes, radiator flushes, solvents, sprays, deodorizers, waxes, cleaners and related products.

A feature of the 36-station filler is an exclusive "magnetic monitor" device on Votator rotary piston units, providing positive control to prevent jammed valves and eliminate resultant down-time, repair costs and replacement of parts. Girdler Process Equip. Div., Chemetron Corp.

Circle E18 green card, last page

Bulletin Gives Condulet For Corrosive Locations

"Condulets for Corrosive Locations" is the title of a 20-page bulletin, just reissued with additional information.

Corrosive substances are listed in tabular form with appropriate corrosion-resistant metals and finishes used condulets. The booklet also contains brief descriptions of the metals and finishes, and includes listings of Plast-A-Coat condulets for hazardous and non-hazardous locations. Crouse-Hinds Co.

Circle E19 green card, last page

Bulletin Covers Treating Of Cooling Water Systems

Hagatreat formula number 168, a corrosion inhibiting compound for treatment of recirculating cooling water systems, is the subject of a new bulletin.

According to the manufacturer, the compound provides complete corrosion control, eliminates sludge deposition, permits more concentration of make-up water, and simplifies control procedures.

The bulletin states that use of the compound will result in steel corrosion rates of less than one mil per year and copper corrosion rates less than a few tenths mil per year. Calgon Co., Div. Hagan Chemicals & Controls, Inc.

Circle E20 green card, last page

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Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
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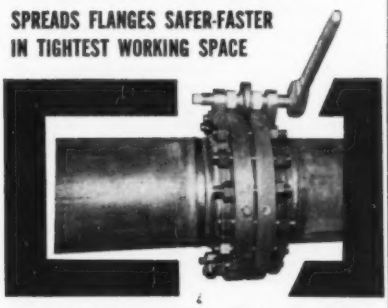

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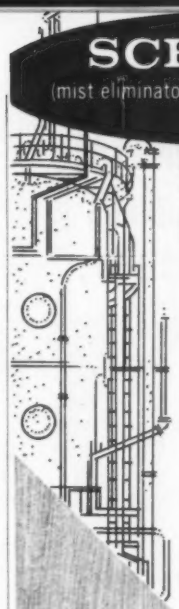
SCHUYLER
(mist eliminators entrainment separators)



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SCHUYLER STYLE 959V, variable density mesh, is a new concept in mist eliminators, offering extreme resistance to coke formation or solids fouling. The increased separation efficiency obtainable with Style 959V will result in carbon residues and metals content 20 to 50 percent lower than obtainable with any competetive mesh type.

The immediate savings to be obtained by reduction of carbon and metals makes Schuyler Style 959V your most economical choice for vacuum towers or other difficult services. For the first time a mist eliminator type is available which offers to an optimum degree: maximum separation efficiency, longer operating life and minimum pressure drop.

SCHUYLER STYLE 959V is an exclusive (patent pending) combination of several types of knitted wire mesh, each engineered to take maximum advantage of its operational strong points. Unlike mist eliminators of uniform density throughout, every portion of a Style 959V mist eliminator is performing its job with maximum efficiency.

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for informative literature which describes our company and our products. Check with us about our unique "no extra cost trial" of Schuyler 959V, it will be worth while to do so. Our engineering staff is at your disposal and you are cordially invited to request their services in helping to solve your most difficult separation problems.

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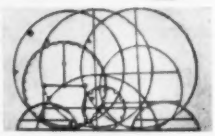
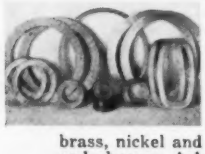


Made in any size or shape needed in double-jacket type. Also cut from solid metal or sheet packing. **Ask for Bulletin 564.**



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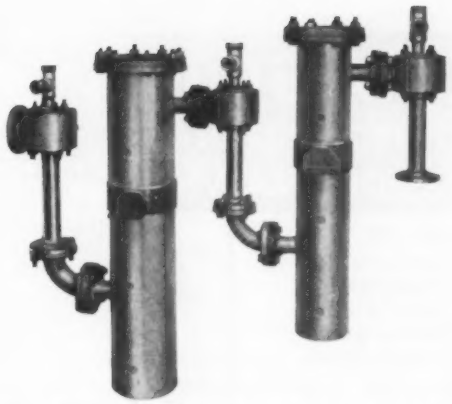

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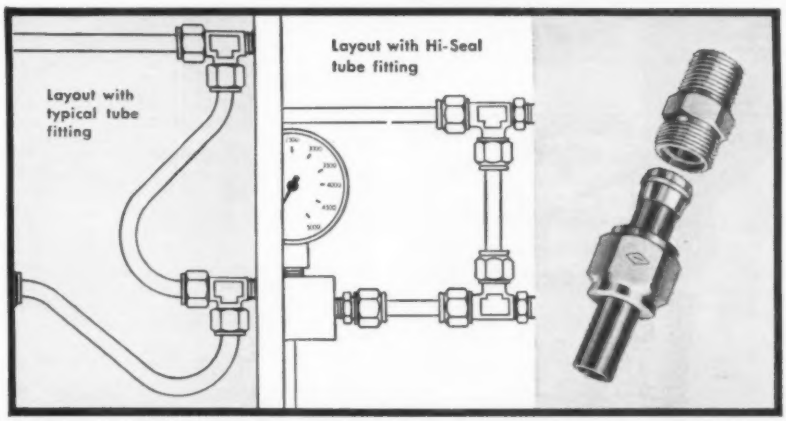

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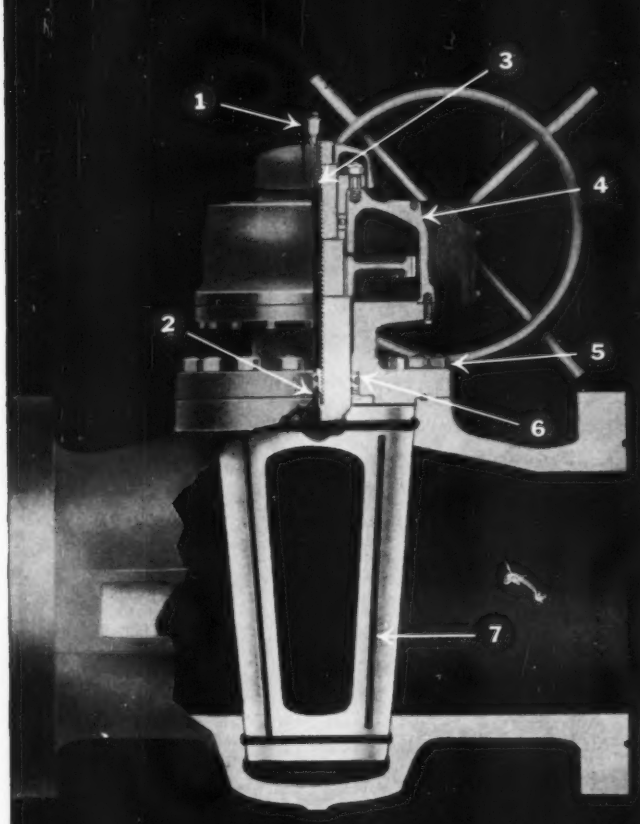

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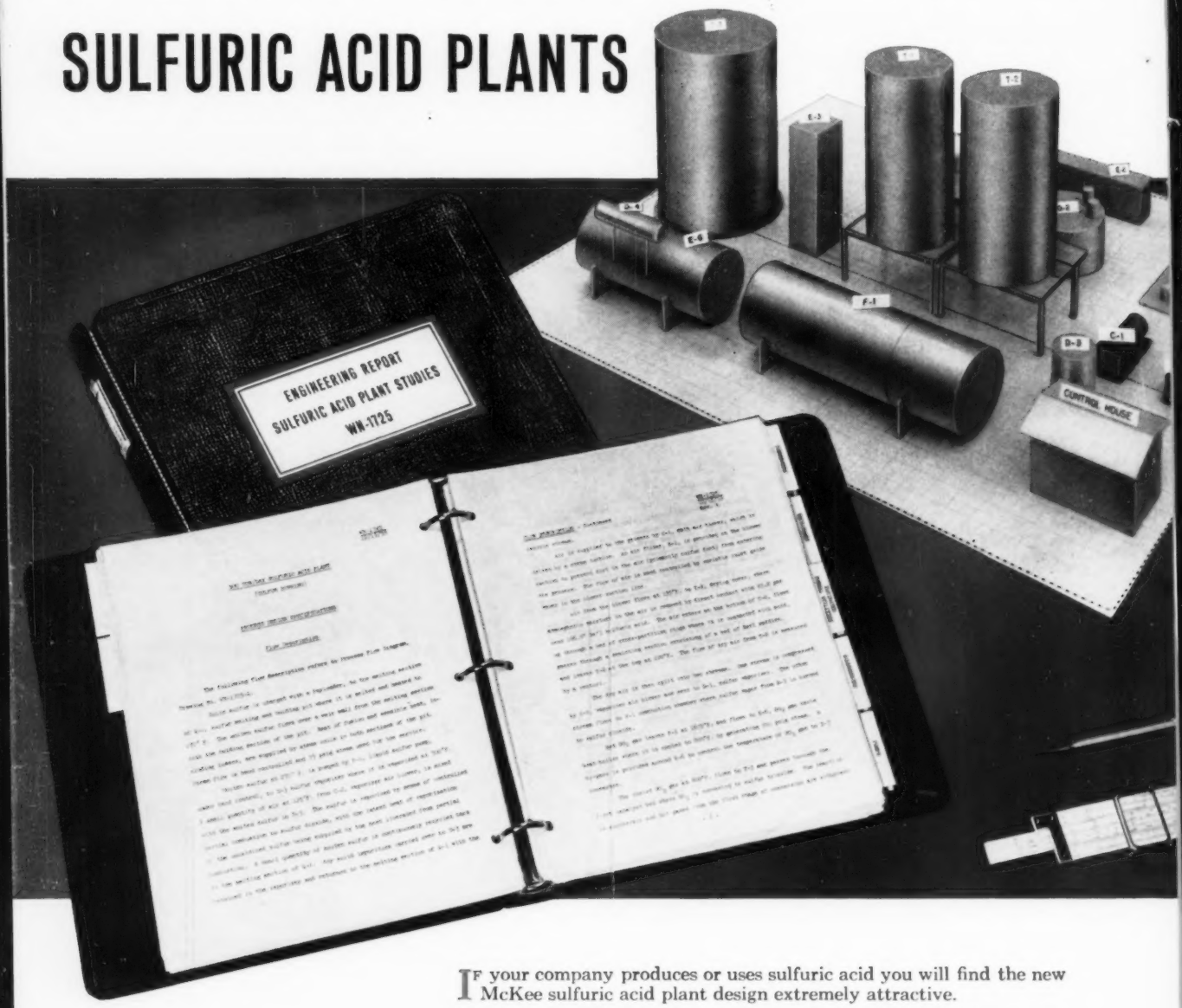

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